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National Air Pollutant Emission Estimates 1940-1990

Pechan (E.H.) and Associates, Inc., Durham, NC

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This report presents U. S. EPA's latest estimates of national and regional emissions for criteria air pollutants: total particulate matter, including fine particulate matter (PM-10); sulfur oxides (SOx); nitrogen oxides (NOx); volatile organic compounds (VOC); carbon monoxide (CO); and lead. This report contains new information on the regional trends of all criteria pollutant emissions including, for the first time, fugitive dust PM-10 emissions. The report also presents emissions for the nation to the years 2000 and 2010 and comparison of ozone season and annual daily average emissions of VOC and NOx.

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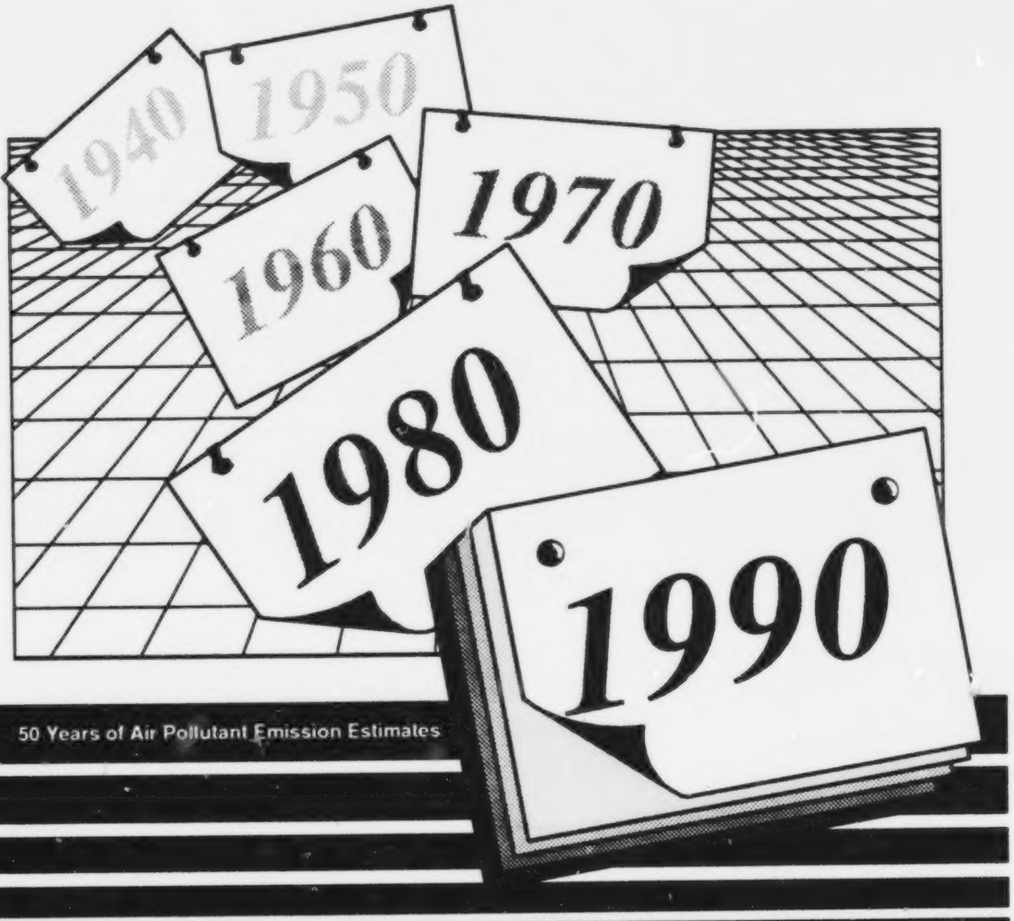

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Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
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November 1991

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FOREWORD

This document presents the most recent estimates of national and regional emissions of the criteria air pollutants. The emissions of each pollutant are estimated for many different source categories, which collectively account for nearly all anthropogenic emissions. The report presents the total emissions from all 48 contiguous States, Alaska and Hawaii, and from ten different regions of the country. The emission trends are updated annually.

This report represents the first of a series which will track the changes in national emissions since the Clean Air Act Amendments of 1990. The emission trends are the net effect of many factors, including changes in the nation's economy and in industrial activity, technology, consumption of fuels, traffic, and other activities which cause air pollution. The trends also reflect changes in emissions as a result of air pollution regulations and emission controls. These reports will serve as a measure of our nation's progress in reducing air pollution as a result of mandatory and voluntary controls and of continuous changes in national activity.

This report also reflects recent improvements in the way national and regional emissions are calculated. Improvement in estimation methods is an on-going effort, and it is expected that future reports will reflect this effort. The emission trends presented in this report are based on consistent methods applied to all years.

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1.0 EXECUTIVE SUMMARY

This report presents the U.S. Environmental Protection Agency's (EPA) latest estimates of national and regional emissions for criteria air pollutants: total particulate matter, including fine particulate matter (PM-10), sulfur oxides (SO_x), nitrogen oxides (NO_x), volatile organic compounds (VOC), carbon monoxide (CO) and lead. Estimates are presented for the past fifty years; 1940 to 1990.

National emissions are estimated annually by the U.S. EPA based on statistical information about each source category, emission factors and control efficiency. The estimates are made for over 450 individual source categories that include nearly all major sources of anthropogenic emissions. The emission estimates for individual source categories are aggregated to show the emission trends at the national and regional levels and by major source category.

Table 1 summarizes the total national emissions of each pollutant from 1940 to 1990. The emissions are expressed in metric units; either teragrams (10^{12} grams) or gigagrams (10^9 grams) per year. One teragram equals one million metric tons, or approximately 1.1 million short tons. (One short ton equals 2,000 pounds.) One gigagram equals one thousand metric tons, or approximately 1.1 thousand short tons. Table 1 also presents the percentage change in total national emissions of each pollutant for the past fifty, twenty and ten years and since 1989.

Emissions of SO_x are expressed as weight equivalent sulfur dioxide and emissions of NO_x are expressed as weight equivalent nitrogen dioxide. The VOC emissions referred to in this report include non-methane volatile organic compounds.

1.1 What's New in This Report

This report contains new information on the regional trends of all criteria pollutant emissions including, for this first time, fugitive dust PM-10 emissions, from 1985 to 1990. (PM-10 includes particulate matter less than 10 micrometers or less in diameter.) This report also presents emission projections for the nation to the years 2000 and 2010, and comparison of ozone season and annual daily average emissions of VOC and NO_x. In addition, the report is being made available earlier this year than in previous years as a result of an accelerated schedule and a revised method for updating the emission trends.

1.1.1 Inclusion of PM-10 Emissions

PM-10 emissions were estimated in response to an EPA rule published on July 1, 1987, establishing an ambient air quality standard for PM-10. This standard replaced the previously existing standard for total suspended particulate matter. PM-10 emissions are estimated for the same point and fugitive process source categories included in the total particulate emission estimates, and for fugitive dust sources including agricultural tilling, construction activity, mining and quarrying, paved roads, unpaved roads and wind erosion. Fugitive dust PM-10 sources had been omitted from previous national emission estimates.

1.1.2 Inclusion of Regional Emission Trends

For the first time, the national emission trends have been disaggregated to show the emission trends in different regions of the country. Essentially the same method was used for deriving the national emission estimates, except that region-specific activity data were used for each source category.

TABLE 1. SUMMARY OF ESTIMATES OF NATIONWIDE EMISSIONS

Pollutant (Teragrams/Year)	1940	1950	1960	1970	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Total Particulate Matter	23.1	24.9	21.6	18.5	10.6	8.5	8.0	7.1	7.1	7.4	7.2	6.7	6.9	7.5	7.2	7.5
PM-10 (Point and Fugitive Process Sources)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6.0	5.6	5.8	6.3	6.1	6.4
PM-10 (Fugitive Dust Sources)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.5	45.3	38.1	54.3	48.5	40.8
Sulfur Oxides	17.6	19.8	19.7	28.3	25.8	23.4	22.5	21.2	20.6	21.5	21.1	20.9	20.5	20.6	20.8	21.2
Nitrogen Oxides	6.9	9.4	13.0	18.5	19.6	20.9	20.9	20.0	19.4	19.8	19.9	19.1	19.4	20.0	19.8	19.6
Non-Methane Volatile Organic Compounds	15.2	18.1	21.0	25.0	21.1	22.6	21.3	19.6	20.4	21.2	20.1	19.0	19.3	19.4	18.5	18.7
Carbon Monoxide	82.6	87.6	89.7	101.4	84.1	79.6	77.5	72.5	74.5	71.9	68.7	63.2	63.4	64.7	60.4	60.1
Lead (Gigagrams/Year)	NA	NA	NA	203.8	147.0	70.6	56.0	54.5	46.6	40.2	20.1	8.4	8.0	7.6	7.2	7.1

PERCENT CHANGE

Pollutant	1940-1990	1970-1990	1980-1990	1989-1990
Total Particulate Matter	-68	-59	-12	4
PM-10 (Point and Fugitive Process Sources)	NA	NA	NA	5
PM-10 (Fugitive Dust Sources)	NA	NA	NA	-16
Sulfur Oxides	21	-25	-9	2
Nitrogen Oxides	184	6	-6	-1
Non-Methane Volatile Organic Compounds	23	-31*	-17	1
Carbon Monoxide	-27	-41	-25	-1
Lead	NA	-97	-90	-1

Notes: NA means not available.
1990 estimates are preliminary.
Negative percent change indicates a decrease.
*Percent change is based on an adjusted estimate for highway vehicles in 1970 to reflect recent changes in estimation method. Refer to Section 4.1.1 for details.

1.1.3 Emissions Projections

National emissions of sulfur and nitrogen oxides, non-methane volatile organic compounds and carbon monoxide are projected to the year 2000 and 2010. These projections are based on future economic and activity growth projections and the expected emission reductions due to the implementation of the Clean Air Act Amendments of 1990.

1.1.4 Earlier Reporting

In addition, emission trends are presented about four months earlier than in previous annual reports. Where final information for a source category was not available for estimating emissions, the 1990 emissions estimate is based on the emission trend in the past seven years for that category. Exceptions to this approach include highway vehicles, electric utilities, copper smelters, forest fires and natural gas combustion sources for which actual data were available. As a result, the 1990 emission estimates are considered preliminary. Final estimates for 1990 will be presented in the next annual report.

1.2 Emission Estimates for 1990

In 1990, the U.S. economy operated at a slightly reduced level from 1989 because of the onset of a recession. Coal consumption, a major source of sulfur oxides, increased, as did overall vehicular traffic, a major source of volatile organic compounds, carbon monoxide and nitrogen oxides. Also, more land was burned by forest fires in 1990 compared to 1989, resulting in slightly increased air pollution. Industrial activity varied; some source categories increased production while others did not. The net effect on total emissions of all of these changes and of continued emission reductions because of control devices appears to be little changed in 1990 compared to 1989.

During 1990, the U.S. preparation for war in the Middle East was a major news item. The increased activity in domestic military air and other related traffic appears to be a small fraction of overall national traffic activity, resulting in no noticeable increase in national emissions. The following sections present a brief description of the changes in total national emissions of each pollutant from 1989 to 1990.

1.2.1 Particulate Matter Emissions in 1990

The total national emissions for total particulate matter (TP), excluding fugitive dust, are estimated to be 7.5 teragrams. The total national emissions of PM-10 from point and fugitive process sources are estimated to be 6.4 teragrams and from fugitive dust sources are estimated to be 40.8 teragrams. Point and fugitive process sources include transportation, fuel combustion, industrial processes, solid waste disposal, and miscellaneous. The major subcategories comprising these sources are listed in Table 2.

Collectively, industrial processes appear to be the largest contributor to anthropogenic emissions of TP. In 1989, industrial processes contributed 2.7 teragrams, compared to 2.8 teragrams in 1990. In addition, as a result of more area burned by forest fires, especially in Alaska, national TP emissions from forest fires increased from 0.8 teragrams in 1989 to 1.1 teragrams in 1990. The net effect of these changes was an increase in total national emissions of 0.3 teragrams. Total national PM-10 emissions increased from 6.1 teragrams in 1989 to 6.4 teragrams in 1990.

TABLE 2. MAJOR SOURCE CATEGORIES

Category	Subcategory
Transportation	Highway Vehicles (Gasoline and Diesel-Powered)
	Aircraft
	Railroads
	Vessels
	Off Highway Vehicles and Machinery
Stationary Source Fuel Combustion	Electric Utilities
	Industrial Boilers
	Commercial and Institutional Boilers and Furnaces
	Residential Furnaces and Space Heaters
Industrial Processes	Chemical Manufacturing
	Petroleum Refining
	Primary and Secondary Metals
	Iron and Steel Mills
	Mineral Products
	Food Production and Agriculture
	Industrial Organic Solvent Use
	Petroleum Product Production and Marketing
Solid Waste Disposal	Incineration
	Open Burning
Miscellaneous	Forest Fires
	Other Burning (Agricultural Burning, Coal Refuse Burning, and Structure Fires)
	Miscellaneous Organic Solvents Evaporation
Fugitive Dust PM-10 Sources	Paved Roads
	Unpaved Roads
	Agricultural Tilling
	Construction Activity
	Mining and Quarrying
	Wind Erosion

Notes: Refer to Section 4.0 for a description of source categories.

For the purposes of this report, forest fires are considered anthropogenic sources although some fires may be caused by nature.

In 1990, total national fugitive dust PM-10 emissions are estimated to be about six times greater than the total emissions from anthropogenic point and fugitive process sources. The total PM-10 emissions from fugitive dust sources (agricultural tilling, construction, mining and quarrying, paved roads and unpaved roads) is about the same in 1990 as for each of the five previous years. Reduced wind erosion is largely responsible for the decrease in total fugitive dust PM-10 emissions from 1989 to 1990.

Unlike other fugitive dust sources, wind erosion can be highly variable. For example, the total national emissions from wind erosion in 1987 are estimated to be 1.3 teragrams, compared to 15.9 teragrams in 1988. The lack of precipitation in 1988 prior to spring crop planting, especially in the central and western U.S., contributed to greater wind erosion.

1.2.2 Sulfur Oxide Emissions in 1990

The total national emissions of SO_x in 1990 are estimated to be 21.2 teragrams compared to 20.8 teragrams in 1989. The most significant change in SO_x emissions since 1989 appears to have occurred in the stationary source fuel combustion category. Greater consumption of coal by electric utilities and industrial boilers in 1990 accounts for nearly all of the 0.4 teragram increase in total emissions.

Consumption of fuel oil, another major source of SO_x, is difficult to predict because fuel oil deliveries and consumption have not followed a smooth trend in the past few years. Since the 1990 emissions from fuel oil combustion are based on extending the past trend, the resulting emission estimate may noticeably affect the total.

1.2.3 Nitrogen Oxide Emissions in 1990

In 1990, the total national NO_x emissions are estimated to be 19.6 teragrams compared to 19.8 teragrams in 1989. This decrease is due to a slight decrease in NO_x emissions from highway vehicles as older, less efficient automobiles are replaced with newer automobiles. Historically, for the past ten years, national emissions of NO_x have remained nearly constant despite increased vehicular traffic. For example, in 1980, the total national emissions were 20.9 teragrams.

1.2.4 Volatile Organic Compound Emissions in 1990

In 1990, total national non-methane volatile organic compound (VOC) emissions were 18.7 teragrams compared to 18.5 teragrams in 1989. Highway vehicles continue to be a major source of VOC and NO_x. Vehicle miles travelled (VMT) increased from 2,107 x 10^9 miles in 1989 to 2,128 x 10^9 miles travelled in 1990, or 1 about percent. As a result of reduced gasoline volatility and continued replacement of older automobiles, total non-methane VOC emissions from gasoline-powered highway vehicles decreased by 1.6 percent from 1989 to 1990 according to the EPA calculations.

For 1980 to 1990, the EPA recently improved the method for calculating VOC emissions from highway vehicles by including state and monthly ambient temperatures, gasoline volatility guideline values and vehicle miles travelled. The effect of this improvement is that the total national VOC emissions are 12 to 15 percent greater than before. These improvements are described in Section 4.1.1.1. It is possible that further improvements, including the use of actual gasoline volatility data and vehicle speed data, may result in different estimates in the future. Recent tunnel studies and measurements of tailpipe emissions suggest that actual VOC emissions from highway vehicles are much higher than traditional estimates, but as of yet, these suggestions are unsubstantiated by emission models.

VOC emissions from forest fires increased from 0.8 teragrams in 1989 to 1.1 teragrams in 1990 as a result of one-third more land area burned. Most of this increase is a result of widespread fires in Alaska.

1.2.5 Carbon Monoxide Emissions in 1990

In 1990, total national CO emissions are estimated to be 60.1 teragrams compared to 60.4 teragrams in 1989. From 1989 to 1990, the total emissions from transportation sources decreased by 2.4 teragrams. CO emissions from residential fuel combustion also decreased by 0.3 teragrams, while emissions from forest fires increased by 2.3 teragrams due to more land area burned. All other source contributions stayed about the same.

1.2.6 Lead Emissions in 1990

Total national lead emissions decreased from 7.2 gigagrams in 1989 to 7.1 gigagrams in 1990. On a historic basis, lead emissions have changed little in recent years. The sharpest reductions occurred in the 1970s and early 1980s when leaded gasoline was being replaced with unleaded gasoline.

Historically, the greatest decreases in lead emissions occurred prior to the 1980s before the introduction of unleaded gasoline. For example, in 1970, lead emissions from highway vehicles were 156.0 gigagrams, compared to 56.4 gigagrams in 1980. By 1990, the total emissions from highway vehicles were only 2.0 gigagrams.

2.0 NATIONAL EMISSION TRENDS, 1940 TO 1990

This chapter presents the estimated national emission trends both graphically and numerically. All estimates for 1990 are preliminary (as explained in Chapter 3.0) and may change in the future as final information becomes available.

2.1 Summary of Total National Emission Estimates

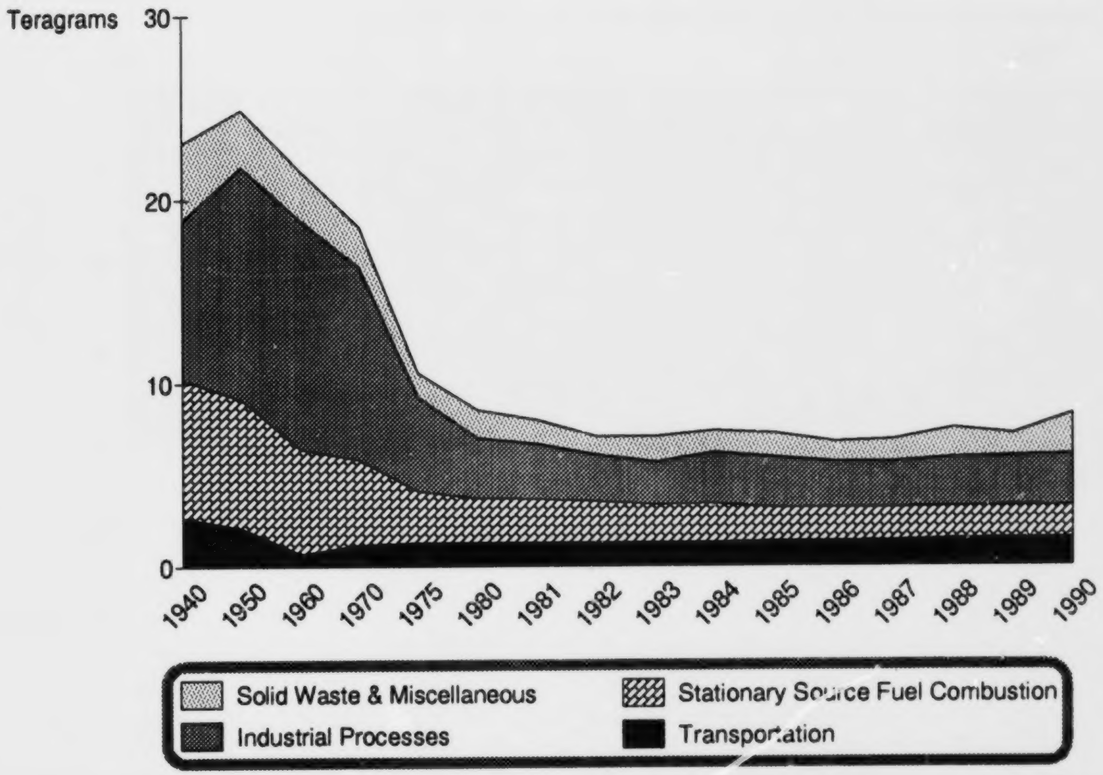
Table 1 summarizes the total national emission estimates from 1940 to 1990 for each criteria pollutant including both TP and PM-10. The estimates are presented for 1940, 1950, 1960, 1970, 1975 and for each year from 1980 to 1990. (National emission estimates are also available for each year from 1970 to 1980, but are not included in this report. These estimates have been presented in earlier reports in this series.)

2.2 Graphical Trend in Total National Emissions

Figures 1 through 7 show the trend in the total national emissions of each pollutant by major source category. The major source categories include transportation sources, stationary source fuel combustion, industrial processes, solid waste disposal, and miscellaneous. Figure 2 shows the trend in fugitive dust PM-10 emissions from 1985 through 1990 and Figure 7 shows the trend in lead emissions from 1970 to 1990. The trend of all other pollutants is shown from 1940 to 1990.

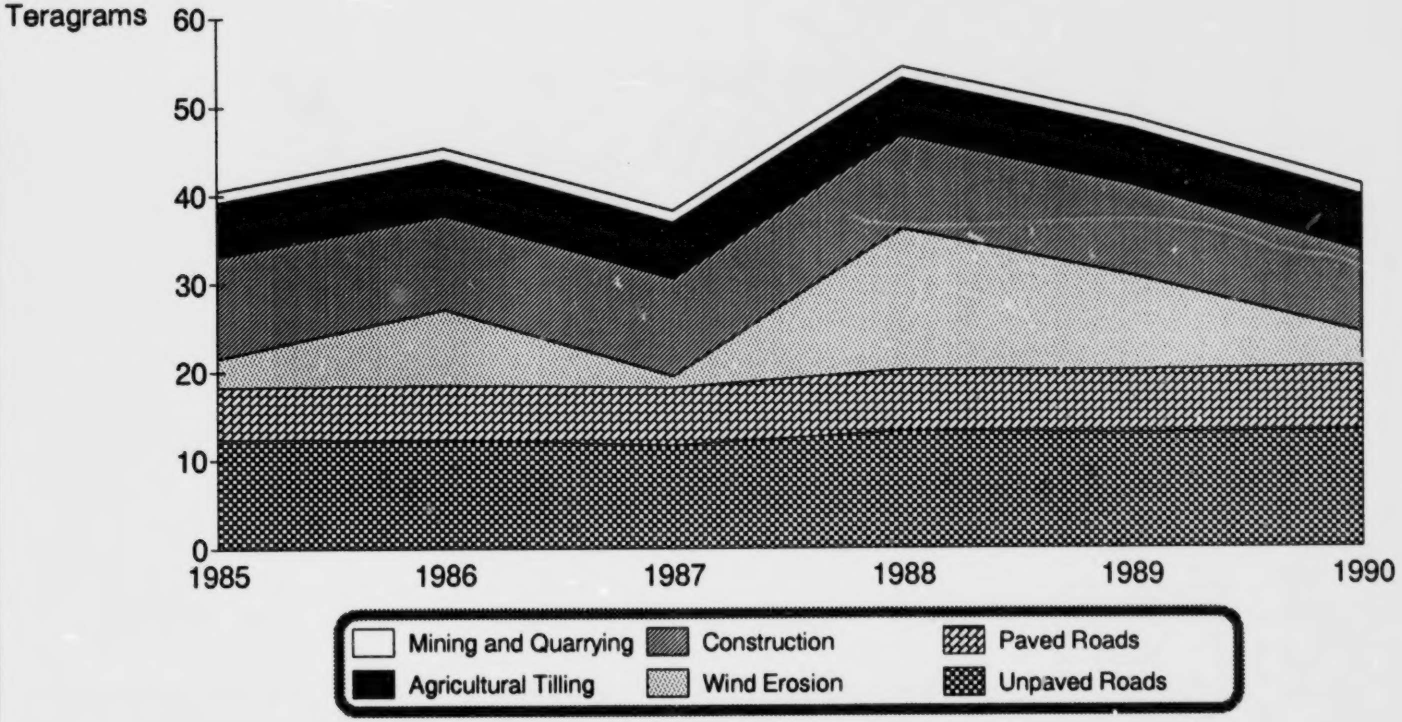
Fugitive dust is a significant component of TP, especially in arid parts of the country. Major sources of fugitive dust PM-10 addressed in this report include agricultural tilling, construction activity, mining and quarrying, paved roads, unpaved roads, and wind erosion.

Figure 1. Trend in TOTAL PARTICULATE MATTER Emissions from 1940 to 1990 for the United States and by Source Category.



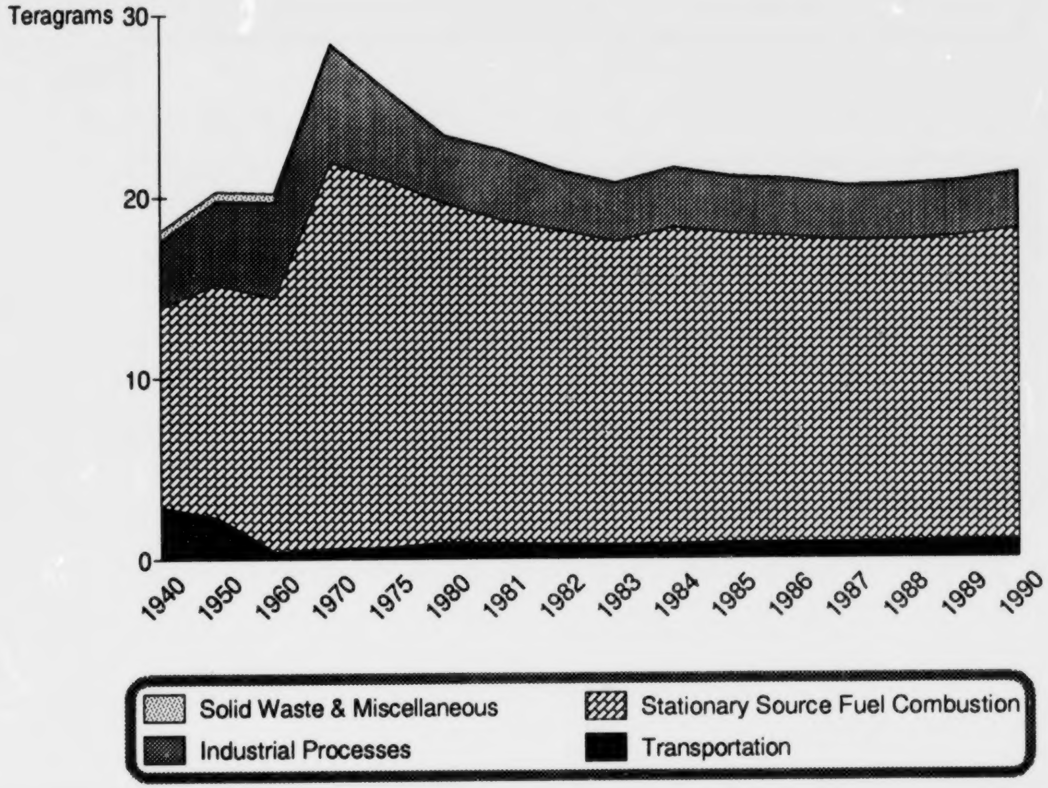
Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs.).

Figure 2. Trend in FUGITIVE DUST PM-10 Emissions from 1985 to 1990 for the United States and by Source Category.



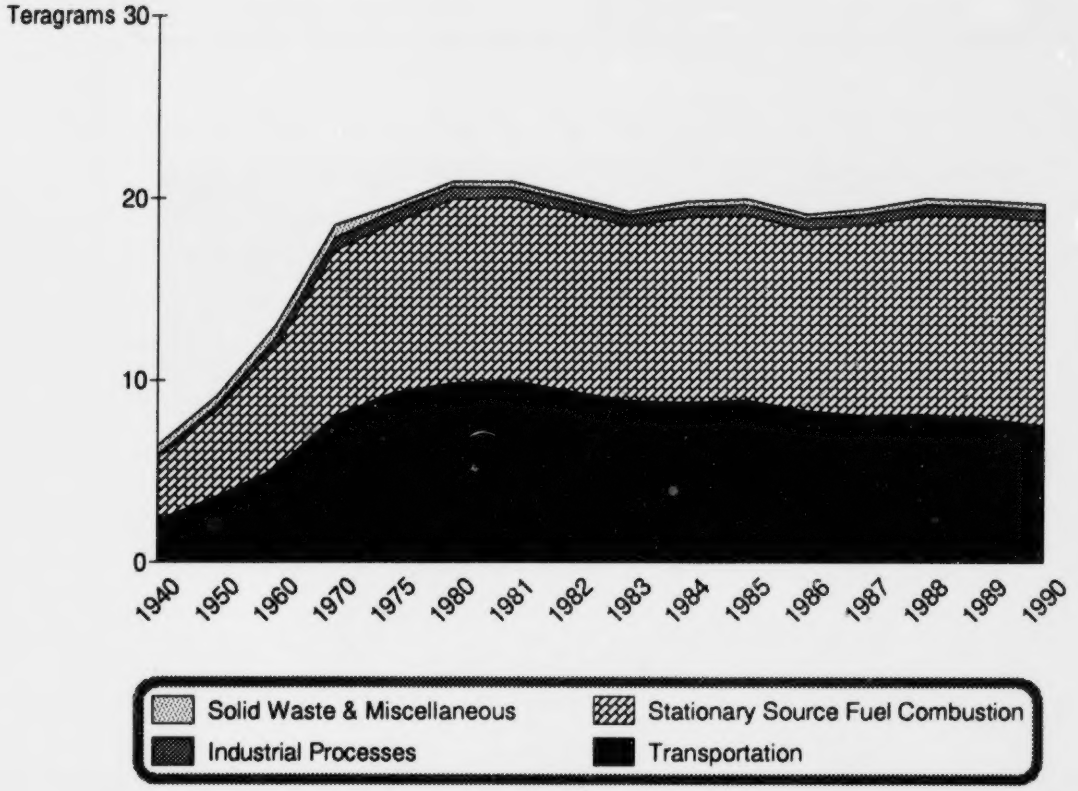
Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs.).

Figure 3. Trend in SULFUR OXIDE Emissions from 1940 to 1990 for the United States and by Source Category.



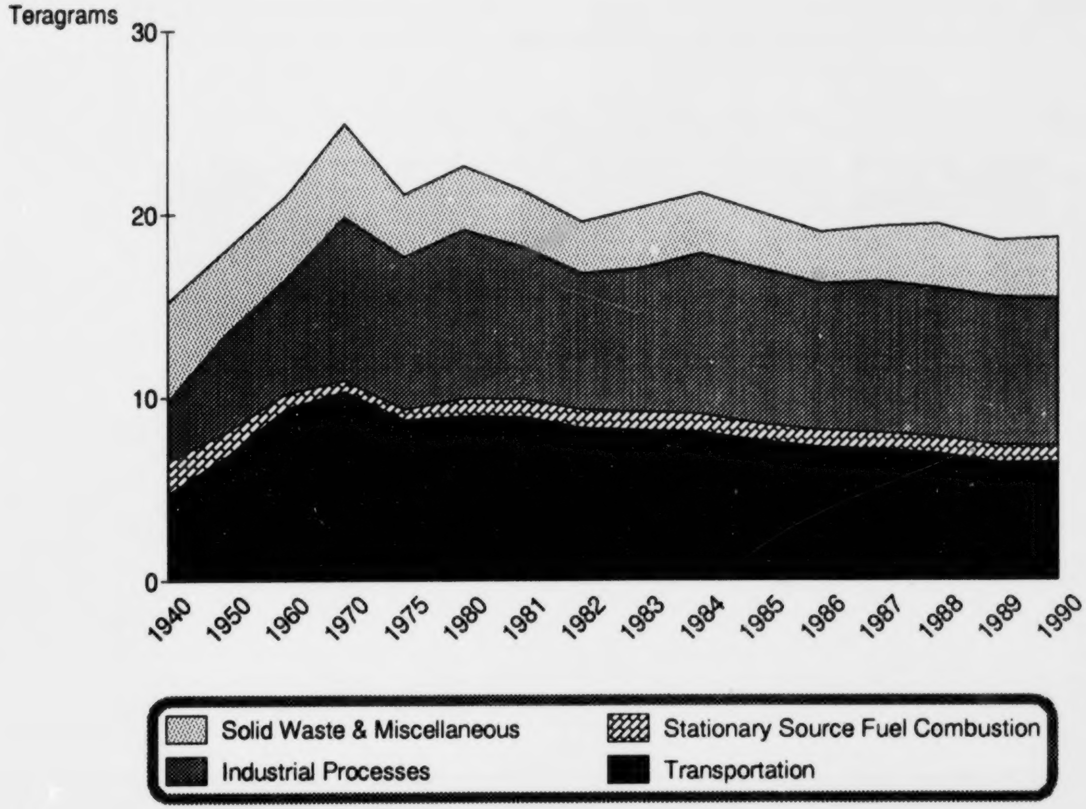
Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs.).

Figure 4. Trend in NITROGEN OXIDE Emissions from 1940 to 1990 for the United States and by Source Category.



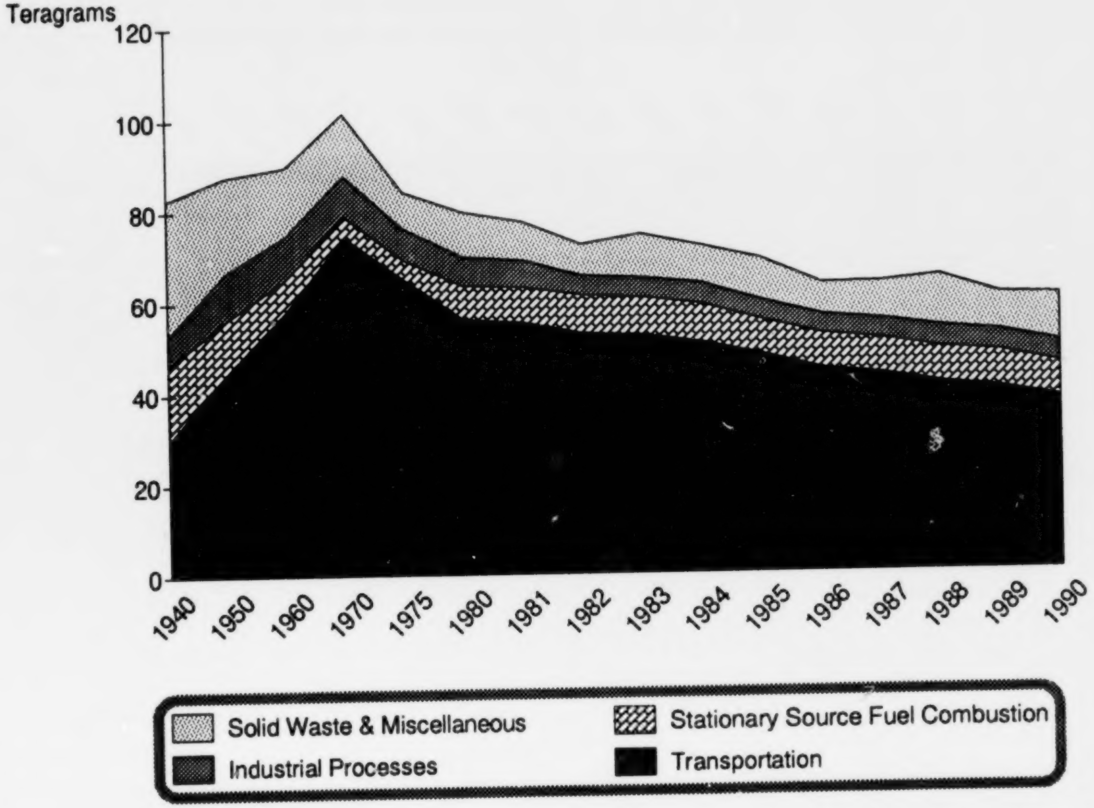
Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs.).

Figure 5. Trend in NON-METHANE VOLATILE ORGANIC COMPOUND Emissions from 1940 to 1990 for the United States and by Source Category.



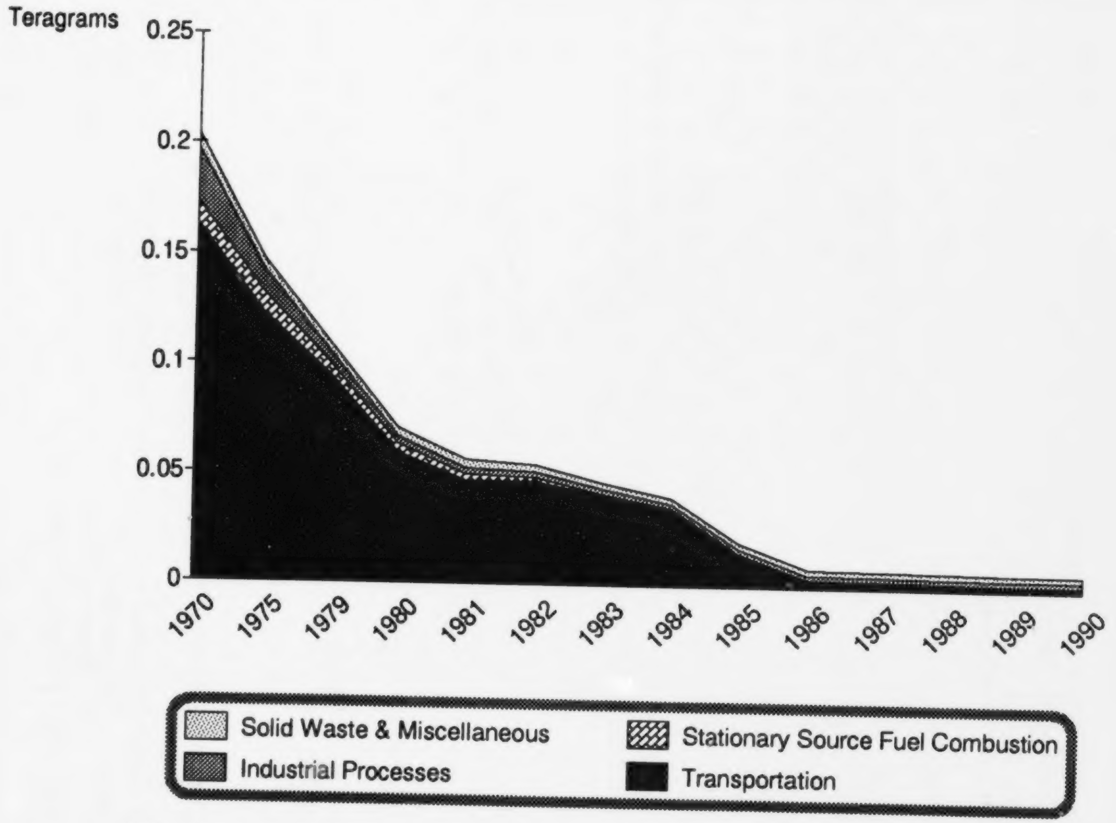
Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs.).

Figure 6. Trend in CARBON MONOXIDE Emissions from 1940 to 1990 for the United States and by Source Category.



Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs.).

Figure 7. Trend in LEAD Emissions from 1970 to 1990 for the United States and by Source Category.



Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs.).

2.3 Total National Emissions by Decade

Tables 3 through 7 present the total national emission estimates for each pollutant, except PM-10 and lead, for each decade from 1940 to 1990, by source category. Estimates of PM-10 emissions are available only for the past six years, and estimates of lead emissions are available only for the past two decades.

2.4 National Emissions by Source Category

Tables A-1 through A-6 in Appendix A present the national emission estimates by source category for 1970, 1975, 1979 and for each year from 1980 through 1990. Table A-6 presents the lead emission estimates, and Table A-7 presents the emission estimates of PM-10 for point and fugitive process sources from 1985 through 1990.

2.4.1 Emissions from Transportation Sources

Tables B-1 through B-6 in Appendix B present the national emission estimates in detail for the transportation source category. Estimates are presented for each criteria pollutant except lead, which is addressed in Table A-6 with other source categories. The estimates are presented for different types of gasoline and diesel powered highway vehicles, aircraft, railroad locomotives, vessels, various machines and other off highway vehicles.

2.4.2 Emissions from Stationary Fuel Combustion Sources

Tables B-7 through B-12 in Appendix B present emission estimates in detail for stationary fuel combustion sources. Estimates are presented for use of coal, fuel oil, natural gas, wood and other fuels.

2.4.3 Emissions from Industrial Processes

Tables B-13 through B-19 in Appendix B present the national emissions in detail for industrial processes. The Standard Industrial Classification (SIC) is shown for each process subcategory. These estimates do not include all SIC categories, only those that are shown.

2.4.4 Emissions from Fugitive Dust PM-10 Sources

Table B-20 presents the estimated national fugitive dust emissions of PM-10 from 1985 to 1990. These estimates include emissions from paved and unpaved roadways, agricultural tilling, construction activity, mining and quarrying, and wind erosion.

3.0 REGIONAL EMISSION TRENDS, 1985 THROUGH 1990

This chapter presents the results of estimating the total emissions by the ten EPA regions shown in Figure 8. When comparing emissions from different regions, it is important to take into account the size of the region, their population, economic activity, predominant types of industry, soil type and other factors that affect air pollution.

Figures 9 through 16 show the trend in the total national emissions of each pollutant, including PM-10, from 1985 through 1990 and by EPA Region. Regional emissions were estimated by source category, in the same manner as for national emissions, but only the total regional emissions are presented in this report. Total regional emissions are presented by pollutant in Tables C-1 through C-7 in Appendix C for each year.

TABLE 3. TOTAL NATIONAL EMISSIONS OF TOTAL PARTICULATE MATTER, 1940-1990 (Teragrams/Year)

Source Category	1940	1950	1960	1970	1980	1990
Transportation						
Highway Vehicles	0.2	0.3	0.6	0.9	1.1	1.3
Aircraft	0.0	0.0	0.0	0.1	0.1	0.1
Railroads	2.4	1.7	0.1	0.1	0.1	0.0
Vessels	0.1	0.1	0.0	0.0	0.0	0.0
Other Off Highway	0.0	0.0	0.0	0.1	0.1	0.1
Transportation	2.7	2.1	0.7	1.2	1.3	1.5
Stationary Source Fuel Combustion						
Electric Utilities	1.3	2.0	2.8	2.3	0.8	0.4
Industrial	3.3	2.8	1.8	1.6	0.5	0.3
Commercial-Institutional	0.4	0.5	0.1	0.1	0.1	0.0
Residential	2.5	1.7	1.0	0.6	1.0	1.0
Stationary Source Fuel Combustion	7.5	7.0	5.7	4.6	2.4	1.7
Industrial Processes						
Iron and Steel Mills	3.0	3.5	1.7	1.2	0.3	0.2
Primary Metal Smelting	0.6	0.6	0.5	0.6	0.1	0.1
Secondary Metals	0.2	0.3	0.2	0.2	0.1	0.1
Mineral Products	2.0	2.9	3.8	2.9	0.7	0.5
Chemicals	0.3	0.4	0.3	0.2	0.1	0.1
Petroleum Refining	0.0	0.0	0.1	0.1	0.1	0.0
Wood Products	0.5	0.8	0.9	0.7	0.2	0.2
Food and Agriculture	0.8	0.8	0.9	0.8	0.6	0.5
Mining Operations	1.3	3.4	4.1	3.9	1.1	1.2
Industrial Processes	8.7	12.7	12.5	10.5	3.3	2.8
Solid Waste Disposal						
Incineration	0.3	0.3	0.4	0.4	0.2	0.1
Open Burning	0.2	0.3	0.5	0.7	0.2	0.2
Solid Waste Total	0.5	0.6	0.9	1.1	0.4	0.3
Miscellaneous						
Forest Fires	2.9	1.7	1.0	0.7	1.0	1.1
Other Burning	0.8	0.8	0.8	0.4	0.1	0.1
Miscellaneous Total	3.7	2.5	1.8	1.1	1.1	1.2
Total of All Sources	23.1	24.9	21.6	18.5	8.5	7.5

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE 4. TOTAL NATIONAL EMISSIONS OF SULFUR OXIDES, 1940-1990
(Teragrams/Year)

Source Category	**1940**	**1950**	**1960**	**1970**	**1980**	**1990**
Transportation						
Highway Vehicles	0.0	0.1	0.1	0.3	0.4	0.6
Aircraft	0.0	0.0	0.0	0.0	0.0	0.0
Railroads	2.7	2.0	0.2	0.1	0.1	0.1
Vessels	0.2	0.2	0.1	0.2	0.3	0.2
Other Off Highway	0.0	0.0	0.0	0.1	0.1	0.1
Transportation Total	2.9	2.3	0.4	0.6	0.9	0.9
Stationary Source Fuel Combustion						
Electric Utilities	2.2	4.1	8.4	15.8	15.5	14.2
Industrial	5.5	5.2	3.5	4.1	2.4	2.3
Commercial-Institutional	1.0	1.7	1.0	0.9	0.7	0.4
Residential	2.3	1.9	1.1	0.5	0.2	0.3
Fuel Combustion Total	11.0	12.9	14.0	21.3	18.7	17.1
Industrial Processes						
Primary Metal Smelting	2.5	2.8	3.0	3.7	1.2	0.5
Pulp Mills	0.0	0.0	0.1	0.2	0.2	0.3
Chemicals	0.2	0.4	0.4	0.5	0.3	0.2
Petroleum Refining	0.2	0.3	0.6	0.7	0.8	1.0
Iron and Steel	0.5	0.6	0.6	0.7	0.5	0.4
Secondary Metals	0.0	0.0	0.0	0.0	0.0	0.0
Mineral Products	0.3	0.5	0.5	0.6	0.6	0.6
Natural Gas Processing	0.0	0.0	0.1	0.1	0.1	0.2
Industrial Processes Total	3.7	4.6	5.3	6.4	3.8	3.1
Solid Waste Disposal						
Incineration	0.0	0.0	0.0	0.0	0.0	0.0
Open Burning	0.0	0.0	0.0	0.0	0.0	0.0
Solid Waste Total	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous						
Forest Fires	0.0	0.0	0.0	0.0	0.0	0.0
Other Burning	0.5	0.5	0.5	0.1	0.0	0.0
Miscellaneous Total	0.5	0.5	0.5	0.1	0.0	0.0
Total of All Sources	17.6	19.8	19.7	28.3	23.4	21.2

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE 5. TOTAL NATIONAL EMISSIONS OF NITROGEN OXIDES, 1940-1990
(Teragrams/Year)

Source Category	**1940**	**1950**	**1960**	**1970**	**1980**	**1990**
Transportation						
Highway Vehicles	1.4	2.2	3.8	6.3	7.9	5.6
Aircraft	0.0	0.0	0.0	0.1	0.1	0.1
Railroads	0.6	0.9	0.7	0.6	0.8	0.5
Vessels	0.1	0.1	0.1	0.1	0.2	0.2
Other Off Highway	0.2	0.4	0.5	0.8	1.0	1.1
Transportation Total	2.3	3.6	5.1	8.0	9.8	7.5
Stationary Source Fuel Combustion						
Electric Utilities	0.6	1.2	2.3	4.4	6.4	7.3
Industrial	2.3	2.9	3.7	3.9	3.1	3.3
Commercial-Institutional	0.2	0.3	0.3	0.3	0.3	0.2
Residential	0.3	0.3	0.4	0.4	0.4	0.4
Fuel Combustion Total	3.4	4.7	6.7	9.1	10.1	11.2
Industrial Processes						
Petroleum Refining	0.1	0.1	0.2	0.2	0.2	0.2
Chemicals	0.0	0.0	0.1	0.2	0.2	0.1
Iron and Steel Mills	0.0	0.1	0.1	0.1	0.1	0.0
Pulp Mills	0.0	0.0	0.0	0.0	0.0	0.0
Mineral Products	0.1	0.1	0.1	0.2	0.2	0.2
Industrial Processes Total	0.2	0.3	0.5	0.7	0.7	0.6
Solid Waste Disposal						
Incineration	0.0	0.1	0.1	0.1	0.0	0.0
Open Burning	0.1	0.1	0.2	0.3	0.1	0.1
Solid Waste Total	0.1	0.2	0.3	0.4	0.1	0.1
Miscellaneous						
Forest Fires	0.7	0.4	0.2	0.2	0.2	0.2
Other Burning	0.2	0.2	0.2	0.1	0.0	0.0
Miscellaneous Total	0.9	0.6	0.4	0.3	0.2	0.3
Total of All Sources	6.9	9.4	13.0	18.5	20.9	19.6

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE 6. TOTAL NATIONAL EMISSIONS OF NON-METHANE VOLATILE ORGANIC COMPOUNDS, 1940-1990
(Teragrams/Year)

Source Category	1940	1950	1960	1970	1980	1990
Transportation						
Highway Vehicles	4.0	5.7	8.3	9.1	7.7	5.1
Aircraft	0.0	0.1	0.2	0.3	0.2	0.2
Railroads	0.5	0.5	0.2	0.2	0.2	0.1
Vessels	0.0	0.1	0.2	0.3	0.4	0.5
Other Off Highway	0.2	0.4	0.5	0.5	0.5	0.5
Transportation Total	4.7	6.8	9.4	10.3	9.0	6.4
Stationary Source Fuel Combustion						
Electric Utilities	0.0	0.0	0.0	0.0	0.0	0.0
Industrial	0.1	0.1	0.1	0.1	0.1	0.1
Commercial-Institutional	0.0	0.0	0.0	0.0	0.0	0.0
Residential	1.7	1.2	0.7	0.4	0.8	0.7
Fuel Combustion Total	1.8	1.3	0.8	0.6	0.9	0.9
Industrial Processes						
Chemicals	0.8	1.2	1.1	1.6	1.8	1.9
Petroleum Refining	0.4	0.5	0.7	0.7	1.0	0.7
Iron and Steel Mills	0.3	0.4	0.3	0.4	0.3	0.2
Mineral Products	0.0	0.0	0.0	0.0	0.0	0.0
Food and Agriculture	0.1	0.1	0.2	0.2	0.2	0.2
Industrial Organic Solvent Use	1.0	2.1	2.4	4.0	3.9	3.1
Petroleum Product Production and Marketing	0.7	1.1	1.6	2.1	2.1	2.1
Industrial Processes Total	3.3	5.4	6.3	8.9	9.2	8.1
Solid Waste Disposal						
Incineration	0.4	0.4	0.5	0.5	0.3	0.3
Open Burning	0.5	0.6	0.9	1.3	0.3	0.3
Solid Waste Total	0.9	1.0	1.4	1.8	0.6	0.6
Miscellaneous						
Forest Fires	3.1	1.7	0.9	0.7	0.9	1.1
Other Burning	0.6	0.6	0.5	0.3	0.1	0.1
Miscellaneous Organic Solvent Use	0.8	1.3	1.7	2.3	1.9	1.5
Miscellaneous Total	4.5	3.6	3.1	3.3	2.9	2.7
Total of All Sources	15.2	18.1	21.0	25.0	22.6	18.7

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE 7. TOTAL NATIONAL EMISSIONS OF CARBON MONOXIDE, 1940-1990

(Teragrams/Year)

Source Category	1940	1950	1960	1970	1980	1990
Transportation						
Highway Vehicles	22.6	34.2	47.7	65.3	48.7	30.3
Aircraft	0.0	0.8	1.6	0.9	1.0	1.1
Railroads	3.7	2.8	0.3	0.3	0.3	0.2
Vessels	0.2	0.2	0.6	1.2	1.4	1.7
Other Off Highway	3.4	6.7	8.0	6.8	4.7	4.4
Transportation Total	29.9	44.7	58.2	74.4	56.1	37.6
Stationary Source Fuel Combustion						
Electric Utilities	0.0	0.1	0.1	0.2	0.3	0.3
Industrial	0.4	0.5	0.6	0.7	0.7	0.7
Commercial-Institutional	0.1	0.1	0.0	0.1	0.1	0.1
Residential	15.8	10.9	6.4	3.5	6.4	6.4
Fuel Combustion Total	16.3	11.6	7.1	4.5	7.4	7.5
Industrial Processes						
Chemicals	3.8	5.3	3.6	3.1	2.0	1.7
Petroleum Refining	0.2	2.4	2.8	2.0	1.6	0.4
Iron and Steel Mills	1.5	1.1	1.3	1.6	1.0	0.7
Primary Metal Smelting	0.0	0.1	0.3	0.6	0.8	0.7
Secondary Metals	1.0	1.4	1.0	1.1	0.3	0.2
Pulp Mills	0.1	0.2	0.3	0.6	0.7	0.9
Industrial Processes Total	6.6	10.5	9.3	8.9	6.3	4.7
Solid Waste Disposal						
Incineration	2.0	2.5	2.5	2.7	1.2	0.9
Open Burning	1.3	1.8	2.6	3.7	1.0	0.8
Solid Waste Total	3.3	4.3	5.1	6.4	2.2	1.7
Miscellaneous						
Forest Fires	22.8	12.8	6.7	5.1	6.9	8.1
Other Burning	3.7	3.7	3.3	2.1	0.7	0.6
Miscellaneous Total	26.5	16.5	10.0	7.2	7.6	8.6
Total of All Sources	82.6	87.6	89.7	101.4	79.6	60.1

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

Figure 8. EPA Administrative Regions

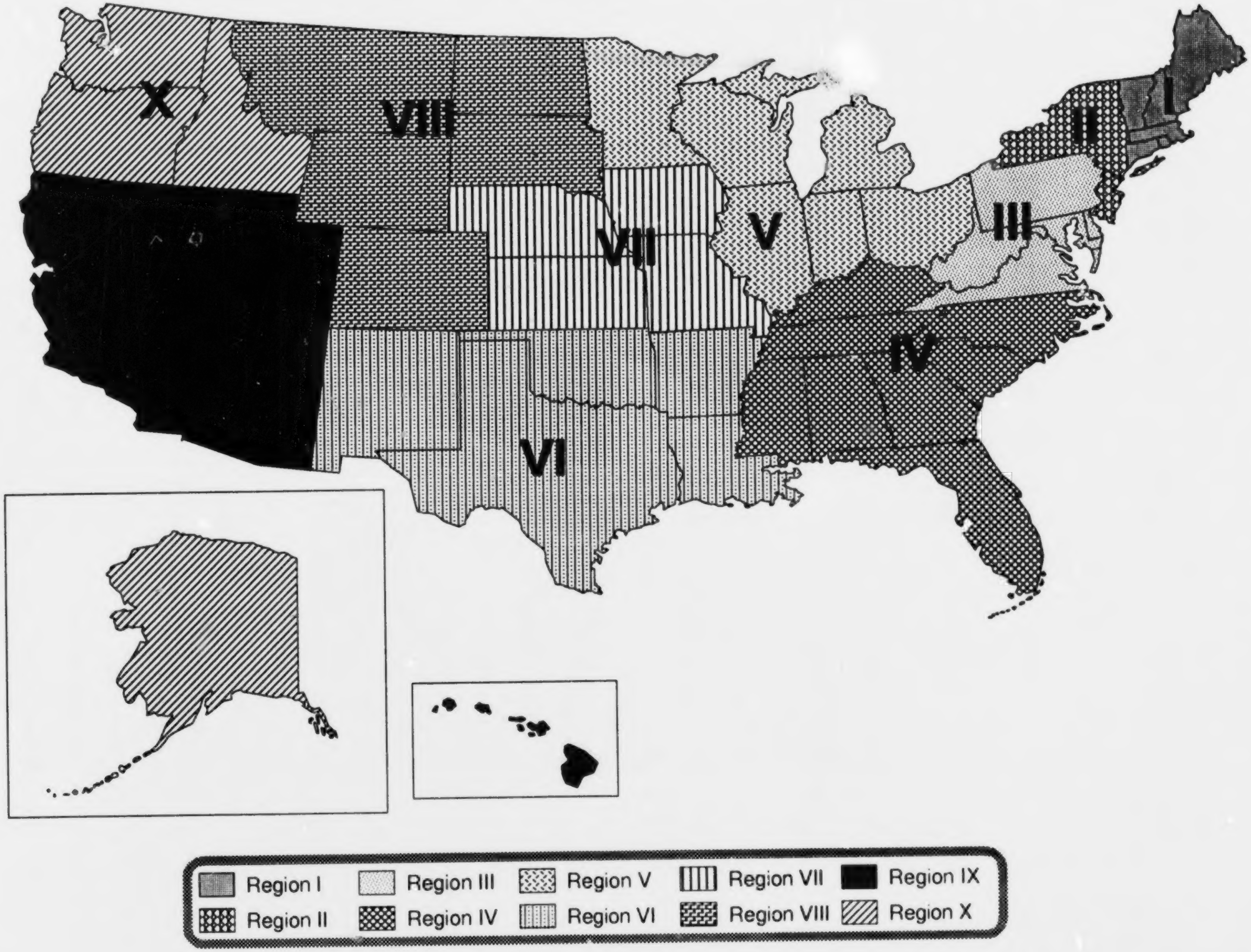
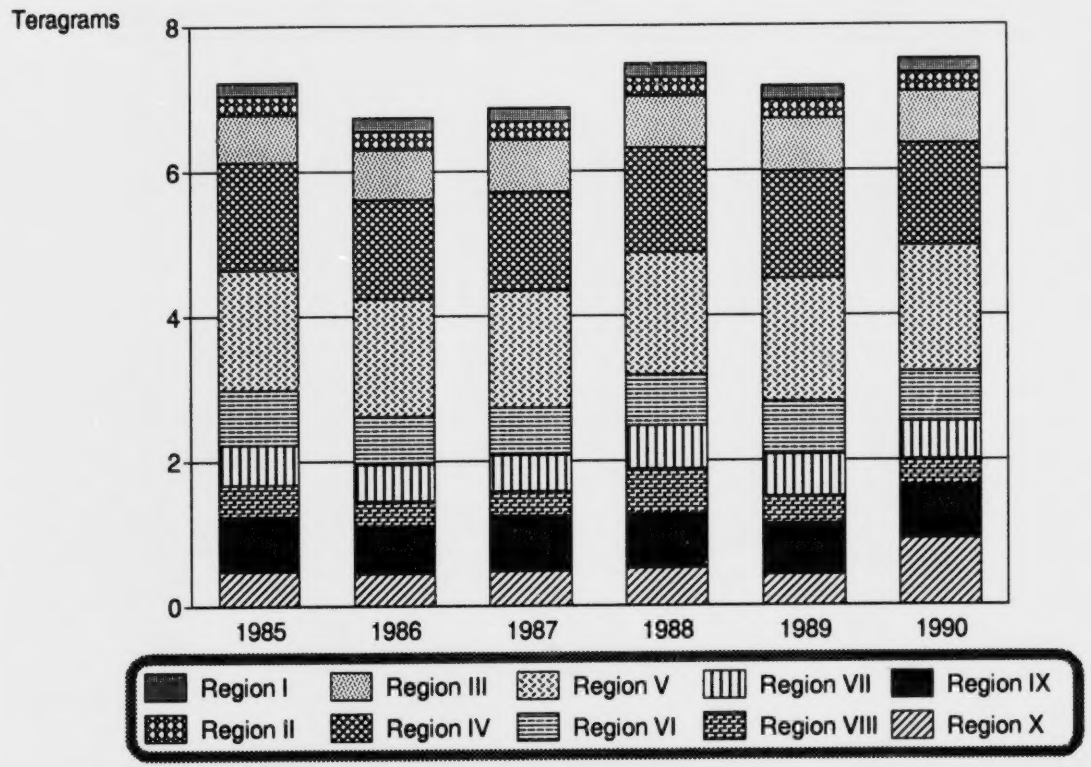
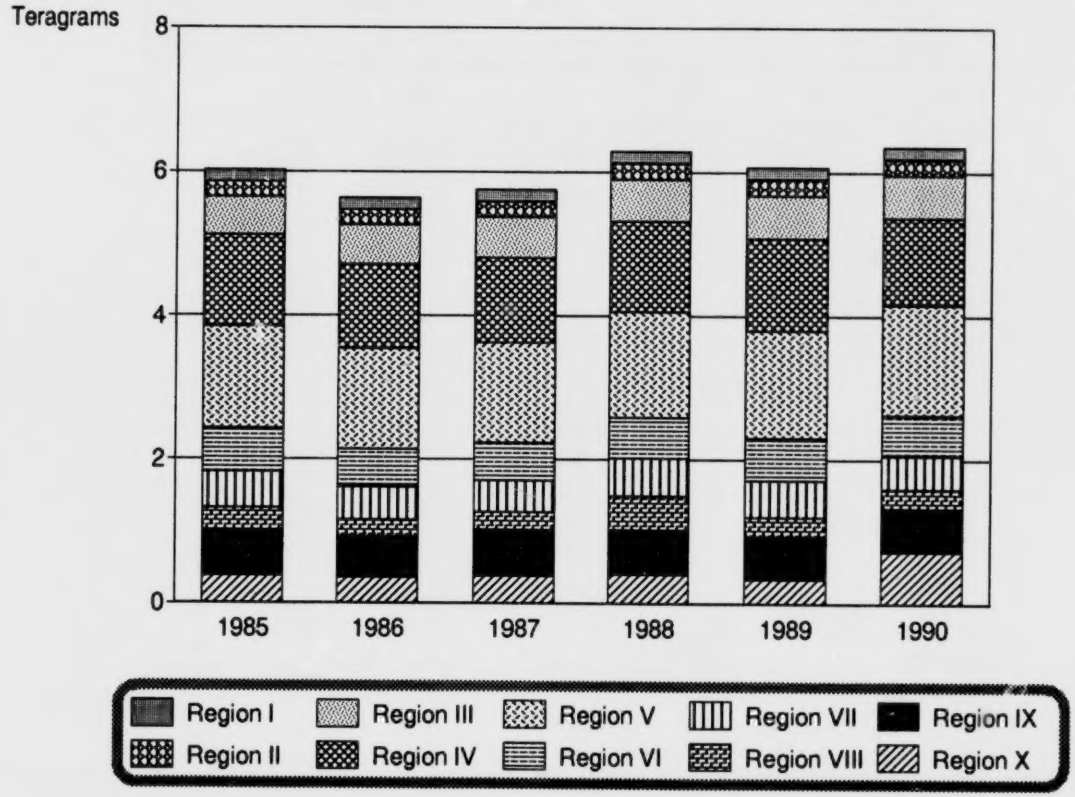

I
II
III
IV
V
VI
VII
VIII
X
Region I
Region II
Region III
Region IV
Region V
Region VI
Region VII
Region VIII
Region IX
Region X

Figure 9. Trend in TOTAL PARTICULATE MATTER Emissions from 1985 to 1990 by Region.



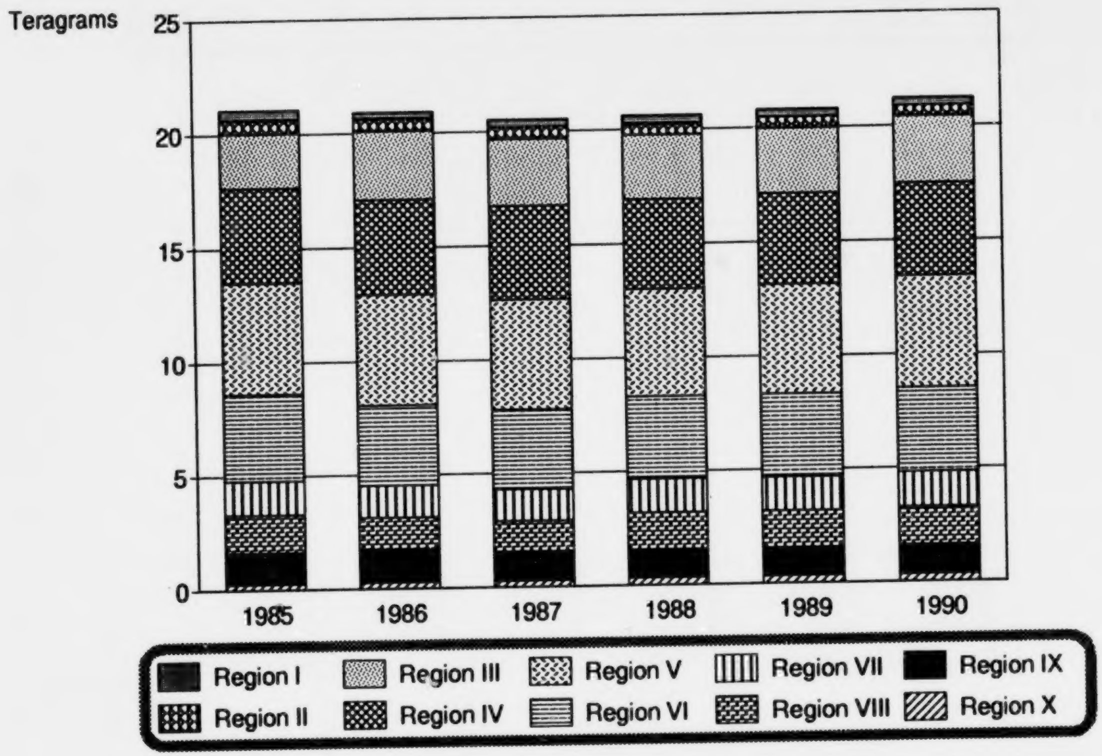
Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs).

Figure 10. Trend in PM-10 Emissions from Point and Fugitive Process Sources by Region from 1985 to 1990.



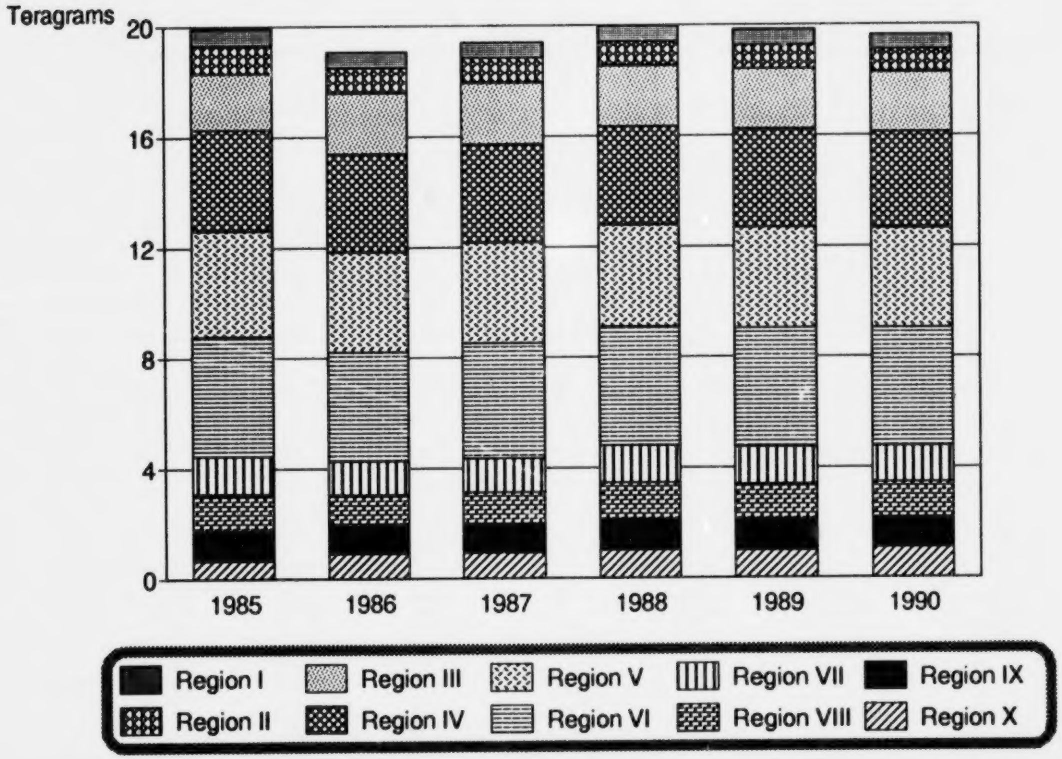
Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs).

Figure 11. Trend in SULFUR OXIDE Emissions from 1985 to 1990 by Region.



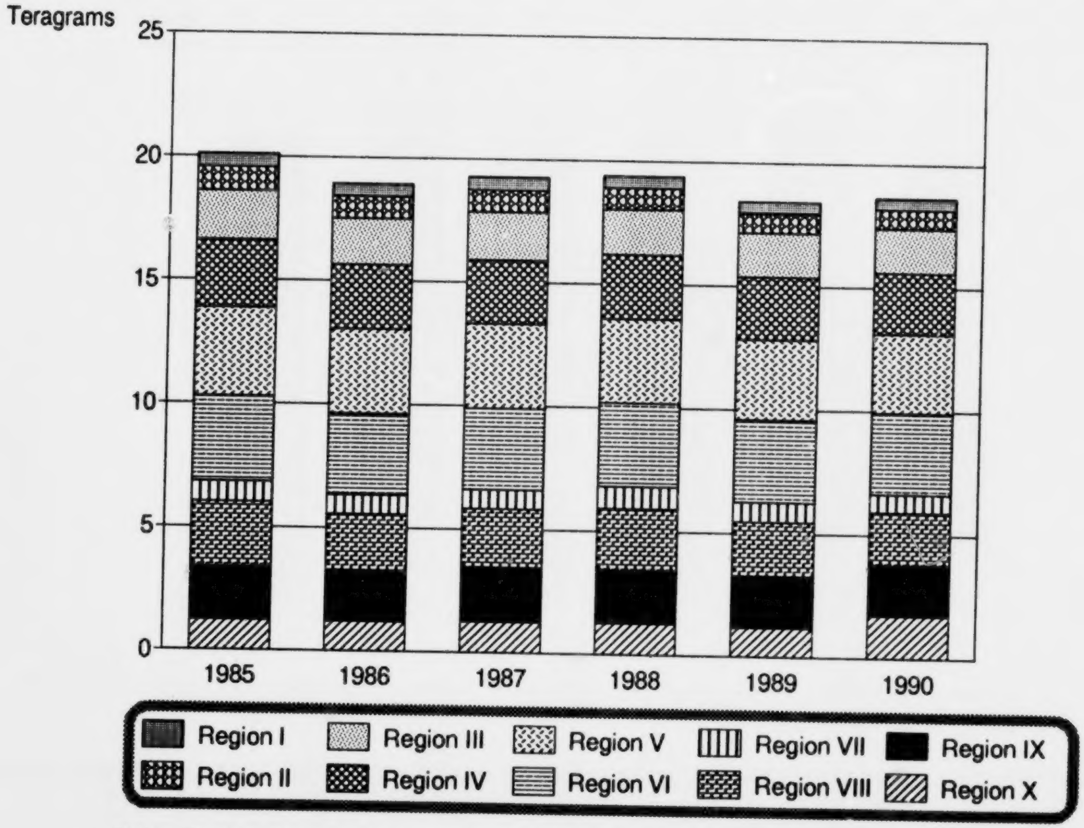
Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs).

Figure 12. Trend in NITROGEN OXIDE Emissions from 1985 to 1990 by Region.



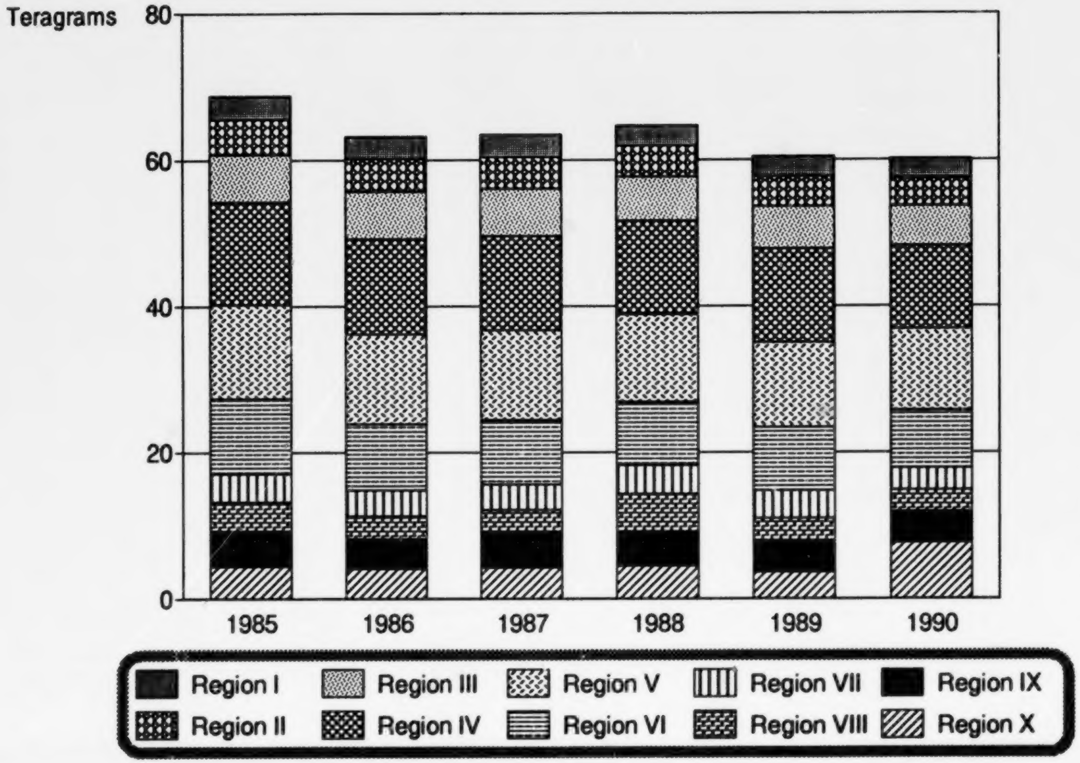
Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs).

Figure 13. Trend in NON-METHANE VOLATILE ORGANIC COMPOUND Emissions from 1985 to 1990 by Region.



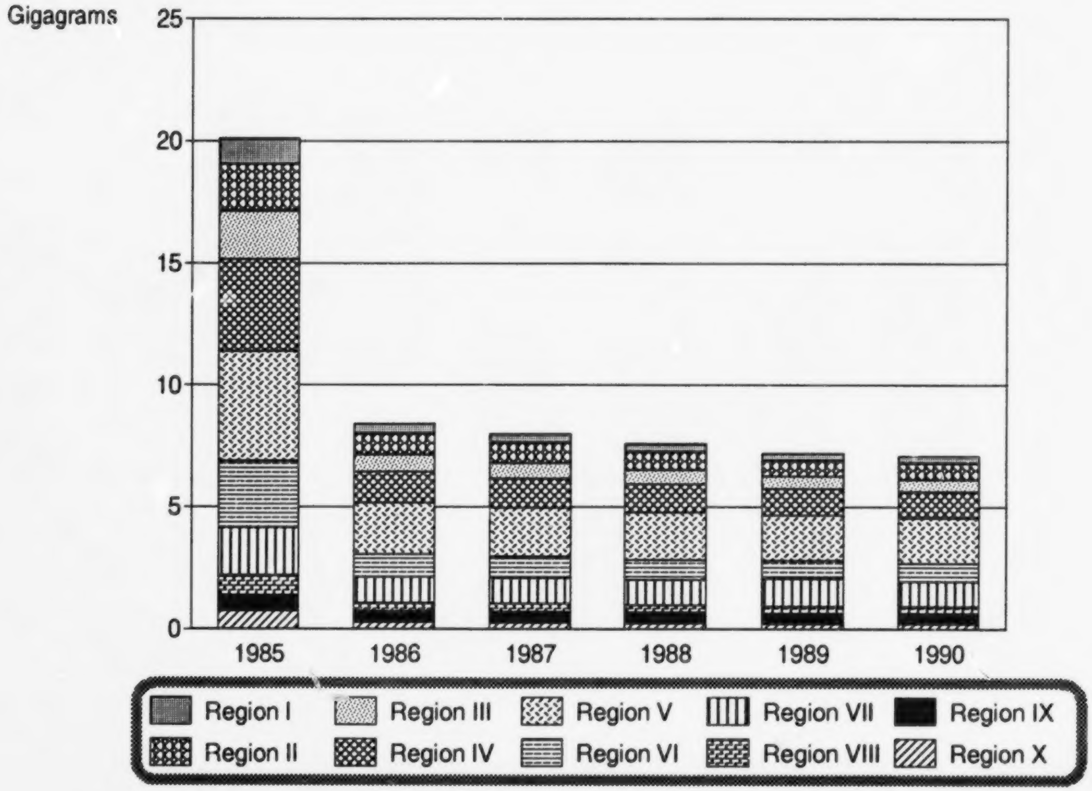
Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs).

Figure 14. Trend in CARBON MONOXIDE Emissions from 1985 to 1990 by Region.



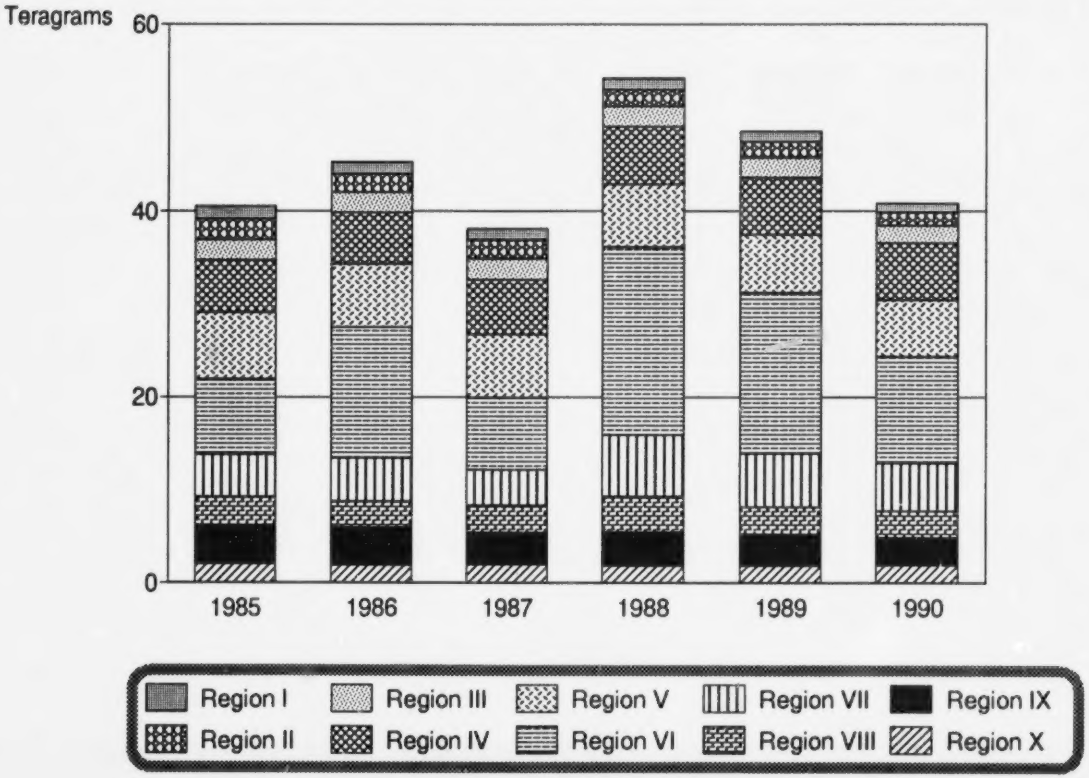
Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs).

Figure 15. Trend in LEAD Emissions from 1985 to 1990 by Region.



Note: One gigagram equals one thousand metric tons, or approximately 1.1 thousand short tons (2000 lbs).

Figure 16. Trend in Fugitive Dust PM-10 Emissions from 1985 to 1990 by Region.



Note: One teragram equals one million metric tons, or approximately 1.1 million short tons (2000 lbs).

The trends in regional emissions generally follow the trends in national emissions for most source categories. This effect is largely due to the fact that each region has a diversity of source categories which reflect the national diversity. Some source categories, however, such as forest fires, prescribed burning, wind erosion and certain industrial processes, have significant regional effects and do not necessarily follow national trends. These source categories will generally account for large changes at the regional level from one year to the next.

4.0 METHODOLOGY

The estimation of national emissions by pollutant and by year involves many steps. Ideally, national emission estimates should be the result of adding the emissions of each individual source in the country. However, this is not possible, and therefore, reliable emission estimates must be based on a "top-down" calculation approach.

The methods used to prepare the estimates presented in this report are as similar as possible to those used for Aerometric Information Retrieval System (AIRS) data preparation.[1] To develop the AIRS point source file, a complex calculation procedure must be followed which includes source-by-source and plant-by-plant emissions calculations. Individual point source estimates are added to the state level totals, and these are then added to the national level figures.

To develop the AIRS area source file, statistical information must be collected on each type of area source. Area sources include many small sources (generally producing emissions of less than 100 tons per year) that are too numerous to account for individually. Residential fuel combustion and solid waste disposal are examples of area sources.

In addition, fugitive dust emissions (emissions from unconfined sources such as storage piles, material loading and wind erosion of land) must be estimated. These estimates are based on large-scale data and various calculation procedures developed in recent years. Fugitive dust may include particulate matter of various size, but for the purposes of this report, is considered equivalent to PM-10.

4.1 Calculation Procedure

Since it is impossible to measure the emissions of every source individually, a "top-down" estimating procedure must be used. The emissions are calculated either for individual sources or for many sources combined, using indicators of emissions. Depending on the source category, these indicators may include fuel consumption or deliveries, vehicle miles travelled, tons of refuse burned, raw material processed, etc. When indicators are used, emission factors which relate the quantity of emissions to the activity indicator must also be used.

Emission factors are not necessarily precise indicators of emissions. They are quantitative estimates of the average rate of emissions from many sources combined. These factors are most valid when applied to a large number of sources. If their limitations are recognized, emission factors are extremely useful tools for estimating national emissions.

The basic "top-down" calculation procedure for most source categories, excluding highway vehicles and copper smelters, may be represented by the following equation:

$$E_{p,s} = A_s \times EF_{p,s} \times \left(1 - \frac{C_{s,p}}{100}\right) \qquad \text{eq. 1}$$

where, E = emissions
p = pollutant
s = source category
A = activity level
EF = emission factor
C = percent control efficiency

National activity data for individual source categories are obtained from many different publications. Emission factors are generally obtained from the U.S. EPA's Compilation Of Air Pollutant Emission Factors, AP-42[2], and from the EPA's mobile source emission factor model available at the time of calculation, MOBILE4.[3] (MOBILE4.1 was not available at the time, but will be used for updating the emission trends next year.) The overall control efficiency of a source category is currently derived from AIRS data. In the past, it was derived from the National Emissions Data System (NEDS),[4] the predecessor of AIRS, and from the 1985 National Acid Precipitation Assessment Program (NAPAP) emission inventory.[5]

Exceptions to this approach include electric power plants, copper smelters and highway vehicles. For power plants, SO_x emissions are always calculated on a plant-by-plant basis. For copper smelters from 1975 to 1990, SO_x emissions are obtained from the plants directly through the respective state air pollution agencies. For highway vehicles, emissions are calculated by state and month, using a method described in Section 4.1.1.

The following sections describe the methodology used for estimating the annual emissions from 1940 to 1990 by major source category.

4.1.1 Transportation

This category includes gasoline and diesel-powered motor vehicles, aircraft, railroad, vessels and nonhighway use of motor fuels.

4.1.1.1 Highway Vehicles--

Emissions from gasoline and diesel-powered motor vehicles are based upon vehicle miles travelled (VMT) and emission factors. Eight vehicle categories are considered; gasoline-powered automobiles, diesel-powered automobiles, light duty gasoline trucks (trucks less than 6,000 pounds in weight), light duty gasoline trucks 6,000 to 8,500 pounds in weight, light duty diesel trucks, heavy duty gasoline trucks and buses, heavy duty diesel trucks and buses, and motorcycles.

Emission factors for VOC, NO_x and CO were obtained from the MOBILE4 model.[3] This model was designed to be used as a tool for estimating exhaust and running loss emissions from highway vehicles in nonattainment areas and in urban air sheds. For VOCs, the model requires information on ambient temperature, vehicle speeds, gasoline volatility, and other variables. For TP and PM-10, emission factors were obtained from AP-42. These emission factors account for tire wear, brake wear and tailpipe exhaust emissions.

For years prior to 1980, the emissions were calculated on the national level only, assuming a single average annual ambient temperature value, a single gasoline volatility value, a distribution of vehicle speed and vehicle type, and a percentage of hot and cold starts. For 1980 and subsequent years, the emissions were calculated on the state and monthly level using a new method.[6] State voluntary fuel volatility guidelines obtained from the American Society for Testing and Materials[7] and average monthly maximum and minimum temperatures in each state were put into MOBILE4. As a result of using this new method, national VOC emissions estimates were about 12 to 15 percent higher than previous estimates.

In both methods, average vehicle speed is based on the published distribution of VMT.[8] Published VMT data are divided into three road categories, corresponding with assumed average speeds of 55 miles per hour for interstates and other primary highways, 45 miles per hour for other rural roads, and 19.6 miles per hour for urban streets. For 1940 and 1950, average speeds were assumed to be 45, 35 and 19.6 miles per hour for these roadway classifications.

Lead emission estimates are based on gasoline consumption, gasoline lead content, percent unleaded gasoline, and emission factors. The lead content of gasoline in 1970 was obtained from the Bureau of Mines, U.S. Department of the Interior[9], and for subsequent years, from AP-42. The percent unleaded gasoline was obtained from the Energy Information Administration, U.S. Department of Energy.[10]

4.1.1.2 Aircraft--

Emissions from aircraft are based on the number of landings and take-offs reported by the Federal Aviation Administration[11] and on AP-42 emission factors for various types of aircraft. Emissions occurring when aircraft are above 3,000 feet are not included in the estimates. Average emission factors are calculated which take into account the national mix of different types of aircraft used for general aviation, military and commercial purposes.

4.1.1.3 Railroads--

Emissions from railroads are based on diesel and residual fuel oil consumption by railroads as reported by the Energy Information Administration.[12] Coal consumption by steam locomotives has been negligible since 1955. Average emission factors were used that are applicable to each type of fuel. In the case of sulfur oxides, the average sulfur content of each fuel was included in the emission factor.

4.1.1.4 Vessels--

The consumption of diesel fuel, residual oil and coal by vessels operating inside the U.S. boundaries was obtained from the U.S. Department of Energy.[10,12,13] Gasoline consumption is based on national boat and motor registrations together with usage factors (gallons/motor/year)[10], and marine gasoline sales as reported by the U.S. Department of Transportation.[8] The estimates of fuel consumption are multiplied by AP-42 emission factors. In the case of coal-fired vessels, an average emission factor for coal combustion in boilers was used.

4.1.1.5 Off Highway Vehicles--

This source category includes farm tractors, other farm machinery, construction equipment, industrial machinery, small general utility engines such as lawn mowers and snowmobiles, and motorcycles. Fuel use is estimated for each subcategory from equipment population data and an annual fuel use factor[14] together with fuel deliveries of diesel fuel reported by the U.S. Department of Energy[12] for gasoline sales reported by the U.S. Department of Transportation[8] for off-highway use.

4.1.2 Stationary Source Fuel Combustion

This major category includes the combustion of bituminous coal, lignite and anthracite coal, fuel oil, natural gas, wood and other fuels.

4.1.2.1 Coal--

The consumption of bituminous coal, lignite and anthracite coal by various end users is reported by the U.S. Department of Energy.[13,15] Most coal is consumed by electric utilities. The reported consumption by source category was multiplied by an average emission factor representative of each category. In the case of sulfur oxide emissions, the emission factor included an average sulfur content value for each type of coal consumed.[16]

In the case of electric utilities, the sulfur oxide emission factor was adjusted to account for the amount of sulfur controlled by flue gas desulfurization systems, according to information reported by the U.S. Department of Energy.[16] In the case of particulate matter, an overall control efficiency was obtained from AIRS for all power plants combined.

4.1.2.2 Fuel Oil--

Residual oil, distillate oil and kerosene are burned by electric utilities, industrial boilers, commercial and institutional boilers, furnaces and residential heaters. The consumption of each fuel type by end user is reported by the U.S. Department of Energy.[12] Average emission factors and sulfur content values are calculated and applied to the consumption data.

4.1.2.3 Natural Gas--

Natural gas consumption is also reported by the U.S. Department of Energy for various end-user groups.[17] AP-42 emission factors were used to calculate the emissions.

4.1.2.4 Wood and Other Fuels--

Consumption of wood has been estimated by the U.S. Department of Energy[18,19] for wood stoves and residential fireplaces. Consumption of bagasse is based on data reported in AIRS. Sales of liquified petroleum gas are reported by the U.S. Department of Energy.[10] Coke and coke-oven gas consumption is obtained from the U.S. Department of Energy.[6] These consumption values were multiplied by appropriate emission factors obtained either from AP-42 or AIRS.

Lead emissions from the combustion of waste oil were based on information obtained from the EPA's Office of Solid Waste. The amount of waste oil burned is assumed to remain constant, while the lead content of waste oil has been assumed to decrease as a result of the general reduction in leaded oil and petroleum products.

4.1.3 Industrial Processes

Production data for industries that produce the majority of emissions were obtained from available publications. Generally, the Minerals Yearbook[9] and Current Industrial Reports[21], published by the Bureau of Census, provide most of the necessary data. Average emission factors were applied to the various production data. Average nationwide control efficiency values for various processes were obtained either from published reports[22], the 1985 NAPAP emission inventory, AIRS or NEDS.

Petroleum product storage and petroleum marketing operations, including gasoline, crude oil and distillate fuel oil storage and transfer, gasoline bulk terminals and bulk plants, and retail gasoline service stations, are included as industrial processes. Also included are industrial surface coating and degreasing operations, graphic arts (printing and publishing), and dry cleaners.

All of these processes involve the use of organic solvents. Emissions from the consumption of organic solvents are estimated from information reported by the U.S. EPA.[23] It is assumed that all solvents consumed eventually evaporate, except in surface coating operations where some of the organic solvent vapors are controlled. The control efficiency of surface coating operations is derived from AIRS.

4.1.3.1 Miscellaneous Industrial Processes for Lead--

Lead emissions from miscellaneous industrial processes include lead alkyl production (a major source of lead) and other minor sources such as type metal production, can soldering, cable covering, and miscellaneous sources. The lead alkyl production is based on information reported by the U.S. International Trade Commission.[24] Production information for other minor sources is obtained from the U.S. Department of Energy.[9]

4.1.4 Solid Waste Disposal

The emissions from this category are based on an assumed solid waste generation rate of 5.5 pounds per capita per day. This value was originally based on a study of solid waste collection and disposal practices.[25] This value is adjusted each year based on information contained in AIRS. Average emission factors are applied to the estimated quantities of solid waste disposal.

4.1.5 Miscellaneous Sources

This major source category includes forest fires, agricultural burning, coal refuse burning and structure fires.

4.1.5.1 Forest Fires--

The U.S. Forest Service of the Department of Agriculture and the U.S. Department of the Interior publish information on the number of forest fires, their location and the acreage burned each year. The amount of forest biomass burned and controlled burning of forest areas each year are estimated by the EPA per acre.[26] Average emission factors were applied to the estimated quantities of materials burned.

4.1.5.2 Agricultural Burning--

A study was conducted by the U.S. EPA to obtain local agricultural and air pollution control agency estimates of the number of acres and quantity of material burned per acre in agricultural burning operations.[26] These data have been updated and used to estimate emissions based on average emission factors.

4.1.5.3 Coal Refuse Burning--

Estimates of the number of burning coal-refuse piles existing in the U.S. are reported by the Bureau of Mines.[27] This publication presents a detailed discussion of the nature, origin, and extent of this source of pollution. Rough estimates of the quantity of emissions were made using this information by applying average emission factors for coal combustion. It should be noted that the number of coal-refuse piles had decreased to negligible by 1975.

4.1.5.4 Structure Fires--

The U.S. Department of Commerce publishes information on the number and type of structures damaged by fires each year.[28] Emissions are estimated by applying average emission factors for wood combustion to these statistics.

4.1.5.5 Nonindustrial Organic Solvent Use--

This source category includes nonindustrial sales of surface coatings for architectural coating, and solvent evaporation from consumer products such as aerosols, deodorants, polishes, toiletries, etc. This category also includes the use of organic compounds such as general cleaning solvents, paint removers, liquification of asphalt paving compounds, and miscellaneous other. Total national organic solvent use is estimated from chemical production reports together with estimates of the portion of total production of each chemical for use as solvent.[23,29] It is assumed that the quantity of all solvent produced is equal to the quantity necessary to make up for solvent loss by evaporation.

4.1.6 Fugitive Dust PM-10 Sources

Estimates of fugitive dust PM-10 emissions were made for the following categories: unpaved roads, wind erosion, agricultural tilling, construction, mining and quarrying, paved roads and burning. An EPA study[30] showed that emissions estimates at both the national and regional level for these source categories would require either modification of existing PM-10 or TP emissions estimation methods or development of new methodologies.[31] As a result, new estimating methods were developed for each category to predict the latest annual emissions. Predictive methods were necessary because much of the necessary data were not available in time to estimate the 1990 emissions. A brief description of the method for each source category follows.

4.1.6.1 Unpaved Roads--

Regional emissions from unpaved roads were determined using the method developed as part of an EPA study to determine the feasibility of developing regional emissions estimates.[30] The method utilized is similar to that developed by NAPAP.[31] Three minor modifications, relative to the NAPAP method, were made in determining the emissions estimates for unpaved roads. First, the AP-42 emission factor for unpaved roads was utilized for all unpaved road surface types. Secondly, a plume depletion factor was not applied to the emissions estimates. These first two modifications were made to be consistent with the approach used for other source categories. AP-42 emission factors are applied throughout to produce the emissions estimates. Plume depletion factors are not (and have not ever been) applied to particulate emissions from other particulate sources. Thirdly, variable (not fixed) values of vehicle speeds, weights, and number of wheels were used to develop the emission factor for unpaved roads.

4.1.6.2 Paved Road Resuspension--

Regional PM-10 emissions from paved road resuspension were estimated by summing state-level emission estimates. A "dry days" term was included in the AP-42 emission factor equation for paved roads similar to the one used in the unpaved road emission factor, in an attempt to account for the effect of precipitation.

An empirical model was used to express the relationship between traffic volume and surface silt loading. Surface silt loading values were determined for various paved road function classes by EPA region. Average daily traffic volume was calculated by dividing the total VMT for a particular functional class, year, and state and then dividing by the number of days in the year.

For the years 1985 to 1989 the total VMT (by EPA region and functional class) was obtained from the Federal Highway Administration.[8] VMT from paved roads were calculated by subtracting the unpaved VMT from the total VMT. For 1990, the total VMT were obtained by EPA region, and rural and urban VMT. The rural and urban VMT were further subdivided into functional classes using the 1989 VMT distribution.

4.1.6.3 Wind Erosion--

Regional PM-10 wind erosion emission estimates for agricultural lands were made by modifying the NAPAP method for estimating wind erosion emissions. The original NAPAP method and the method used here both develop an expectation of the dust flux based on the probability distribution of wind energy. The method developed for this report uses the mean wind speed and information on threshold friction velocity and information on precipitation to predict the wind erosion flux potential for soils.

It should be noted that the emissions estimates developed as part of the NAPAP effort utilized a 30 year wind record and thus represent a 30 year average emission estimate. The wind erosion emission estimates developed for this report use state-level, year-specific wind and activity data.

4.1.6.4 Agricultural Tilling--

Regional PM-10 emissions from agricultural tilling were made using the AP-42 emission factor equation for agricultural tilling with year-specific and state-level emission factor correction parameters and activity data.

4.1.6.5 Construction Activities--

Regional PM-10 emissions were estimated using an emission factor for construction activity and the total number of acres of land under construction in the nation. The average duration of construction was also estimated.

4.1.6.6 Mining and Quarrying--

Regional PM-10 emissions estimates for mining and quarrying operations include the following sources: 1) overburden removal, 2) drilling and blasting, 3) loading and unloading and 4) overburden replacement. Transfer and conveyance operations, crushing and screening operations and storage and travel on haul roads are not included in the estimates.

Metallic ore emissions were calculated by assuming that for the four operations listed above, the PM-10 emission factors for copper ore processing operations apply to all metallic ores. Nonmetallic ore and coal emissions were calculated by assuming that the PM-10 emission factors for western surface coal mining apply to both nonmetallic ores and coal.

4.2 Maintaining Consistency

When estimating national emission trends, it is important to follow a consistent methodology. Should the emission factor for a source category change, for example, then the new factor must be applied to all previous years. Similarly, if an activity indicator for a source category changes, as is sometimes the case when preliminary figures are published, the new value must be used in the calculations for that year. Also, if the calculation method changes for any source category, possibly as a result of improving the method or as a result of a change in available data, the new method must be applied to all previous years. In this way, the emission trends are consistent and the changes in emissions from one year to the next are comparable.

4.3 National Emission Estimates for 1990

For 1990 only, the national emissions are based on preliminary estimates. For previous years, the emissions estimates were based on final published statistics and information which became available almost a year later. A method was developed for providing reliable estimates earlier than before.

The 1990 estimates are based on the activity level, the emission factor for each pollutant and the control efficiency of each source category during the past seven years. Although more than twenty years of consecutive data are available in the EPA trends files, seven years of data were found to provide the best basis for projecting the trend in these variables to the next year. The trend of each variable was projected to 1990 using either a linear regression or a quadratic equation depending on which method provided the best results when applied to 1989 data. The 1990 national emissions were then calculated for each source category using equation 1 shown in Section 4.1.

When the projection method was applied to the seven years of data prior to 1989, the resulting total national emission estimates were nearly identical to the estimates derived by the original method. The percentage difference between the actual emissions and the estimates, as calculated for 1989 on the national level, are summarized below:

Pollutant	Percent Difference
Total Particulate Matter	0.6 %
Sulfur Dioxide	-1.4 %
Nitrogen Oxide	-1.1 %
Non-methane Volatile Organic Compounds	0.7 %
Carbon Monoxide	0.8 %
Lead	4.6 %
PM-10 (Point and Fugitive Process Sources)	1.0 %

Note: A negative sign indicates the preliminary estimates were less than the actual. A positive sign indicates the estimates were greater than the actual.

The preliminary estimation method provides a reasonable indication of changes in annual total national emissions. When combined with actual data for major source categories such as electric utilities, highway vehicles and others, the method provides a reliable indication of trends.

4.4 Regional Emission Estimates

For each source category, except industrial processes, state-level activity data were obtained for 1985 through 1988. In most cases, state-level data were obtained directly from the same references from which national data were obtained. The state-level activity data were aggregated to the EPA regional level and the regional totals were used to develop regional fractions of the national activity. These fractions were multiplied by the national emissions to obtain regional emission estimates by source category. The regional emissions of all source categories were added to produce regional total emissions.

In the case of industrial process categories, except copper smelters, the regional fractions were obtained from the 1985 NAPAP emission inventory. The same fraction was used for each year from 1985 through 1990 because the changes in regional fractions for nonindustrial source categories were found to be negligible from year to year.

5.0 ANALYSIS OF NATIONAL TRENDS, 1940 THROUGH 1990

National trends in air pollutant emissions are a function of a number of factors. Air pollution control measures and economic conditions have the greatest impact on total emissions. National emission trends do not provide any insight into the distribution or concentration of air pollution sources within the United States. For this reason, regional emission trends were developed.

In this report, emissions of SO_x are reported as the equivalent weight of sulfur dioxide (SO_2), which is the predominant sulfur oxide species. Some emissions of sulfur trioxide (SO_3) are also included, but are also expressed as the equivalent weight of SO_2. Emissions of NO_x include predominantly nitric oxide (NO) and nitrogen dioxide (NO_2). Other nitrogen oxides are probably emitted in small amounts. In this report, NO_x emissions are expressed as the equivalent weight of NO_2. Estimates of oxidant emissions are not provided because most oxidant species are secondary pollutants generated by photochemical reactions in the atmosphere.

Emission estimates of VOC, a major ingredient in oxidant-producing reactions, were developed from current emission factors. No adjustments have been made to exclude ethane and other photochemically reactive VOCs or to include chlorofluorocarbons. If no data were available for a source category, the total non-methane hydrocarbon or the total hydrocarbon emission factor from AP-42 was used. Highway vehicle emissions were estimated as non-methane VOCs.

The following sections of this chapter discuss the most important factors influencing the emission trends of each pollutant. The analysis is divided into two parts; 1940 through 1970 when significant changes in technology, activity patterns, and fuel use occurred, and 1970 through 1990 when emissions were being controlled.

In the 1950s and 1960s, particulate matter and smoke emissions were among the first pollutants to be controlled by local air pollution abatement programs. A concerted effort to control the emissions of other pollutants did not begin on the national level until the Clean Air Act of 1970. Since then, considerable progress has been made in reducing emissions of SO_x, NO_x, VOC, CO, lead and fine particulate matter by installing emission control devices on automobiles, electric power plants, industrial processes and other sources. In order to see the general effect of emission controls in the past twenty years, the national emissions in 1970 are compared to the emissions in 1990, assuming the same level of emission control and emission factors in 1990 as in 1970. Table 8 shows the theoretical 1990 emissions by source category.

TABLE 8. THEORETICAL 1990 NATIONAL EMISSIONS BASED ON 1970 CONTROLS (Teragrams/Year)

Source Category	TP	SO_x	NO_x	VOC	CO	LEAD
Transportation						
Highway Vehicles	1.8	0.6	12.1	20.5	107.9	200.1
Non-Highway	0.2	0.4	1.9	1.3	7.5	4.8
Transportation Total	2.0	0.9	14.0	21.9	115.4	205.0
Stationary Source Fuel Combustion						
Electric Utilities	5.4	23.5	8.6	0.0	0.3	0.7
Industrial	1.6	2.7	3.3	0.1	0.7	9.3
Residential/Commercial	1.1	0.7	0.6	0.7	6.5	0.0
Fuel Combustion Total	8.1	26.8	12.5	0.9	7.5	10.0
Industrial Processes (SIC)						
Mining Operations (10,12,13,14)	4.2	0.4	0.0	0.0	0.0	0.2
Food and Agriculture (02,07,20)	1.5	0.0	0.0	0.2	0.0	0.0
Wood Products (24,26)	1.1	0.3	0.0	0.0	1.2	0.0
Chemicals (28)	0.3	0.8	0.3	2.0	2.8	0.1
Petroleum Refining (29)	0.7	1.5	0.2	1.0	2.4	0.0
Mineral Products (32)	2.5	0.8	0.2	0.0	0.0	0.3
Metals (33)	1.2	2.8	0.0	0.2	2.6	15.0
Miscellaneous	0.0	0.0	0.0	6.4	0.0	0.2
Industrial Processes Total	11.5	6.5	0.7	9.8	9.1	15.8
Solid Waste Disposal	0.3	0.0	0.1	0.6	1.7	2.8
Miscellaneous	1.2	0.0	0.3	2.7	8.6	0.0
Total	23.1	34.3	27.5	35.9	142.3	233.6
1990 actual emissions (from Table 1)	7.5	21.2	19.6	18.7	60.1	7.1
1970 actual emissions (from Table 1)	18.5	28.3	18.5	25.0	101.4	203.8
Ratio of theoretical 1990 emissions to actual 1990 emissions	3.08	1.62	1.40	1.92	2.37	32.90
Ratio of theoretical 1990 emissions to actual 1970 emissions	1.24	1.21	1.49	1.44	1.40	1.15

Table 8 shows the approximate effect of emission controls since 1970. It should be noted that to some extent, source category activity levels, emission factors and control efficiency are interrelated. For example, industrial modernization and changes in technology may affect emission factors and may result in cleaner, more energy efficient operations. Also, changes in technology and economic growth patterns may affect source category activity levels. In addition, some emissions may be voluntarily reduced as a result of increased awareness of environmental issues. Therefore, the information presented in Table 8 provides insight into the effect of emission controls, but does not account for changes in activity levels and emission factors as a result of changes in technology, economy and other factors.

5.1 Total Particulate and PM-10

1940-1970

The estimated TP emissions for 1940, 1950 and 1960 were 25 to 17 percent higher than in 1970. Even though industrial production levels and the quantities of fuels consumed were lower than the post-1970 period, emissions were generally uncontrolled before 1970, resulting in greater emissions. In 1940 and 1950, TP emissions from coal combustion by railroads and from forest wildfires were significant. In 1940, for example, railroads contributed about one-tenth of the total national emissions and forest fires contributed about the same.

A large portion of the TP emissions from stationary source fuel combustion resulted from the combustion of coal. In 1940, coal was consumed mostly by the industrial and residential sectors. Since 1940, residential coal use has declined substantially, resulting in a corresponding reduction in emissions. Industrial coal use has also declined, but not to the same extent. Emission controls used by industrial coal consumers have increased over the years and by 1970 emissions had decreased to about half the 1940 level.

Coal combustion by electric utilities has increased from 46 teragrams (51 million tons) in 1940 to 291 teragrams (321 million tons) in 1970. This increase in consumption has resulted in increased emissions from 1940 to 1970. Since 1970, TP emissions from electric utilities have decreased, despite continued increases in coal consumption, as a result of installing air pollution control equipment.

TP emissions from industrial processes increased from 1940 through 1950, primarily as a result of increased industrial production. From 1950 through 1970, industrial output continued to grow, but installation of pollution control equipment more than offset the increase in production.

1970 - 1990

Since 1970, TP emissions have decreased substantially as a result of air pollution control efforts. As shown in Table 8, without emission controls added since 1970, TP emissions would have increased by 24 percent from 1970 to 1990. In reality, TP emissions decreased about 60 percent from 1970 to 1990. The 1990 TP emissions were about a third of the possible emissions had there been no additional controls in place since 1970. Since 1970, industrial processes have contributed most of the anthropogenic TP emissions followed by stationary source fuel combustion, transportation sources and other sources.

In 1970, industrial processes contributed 57 percent of the total and in 1990, only 37 percent indicating considerable progress in reducing emissions. TP emissions from industrial processes have been reduced substantially due to installation of improved control equipment mandated by air pollution control programs. Since 1970, actual emissions from industrial processes declined by 73 percent. Tables B-13 (TP) and B-19 (PM-10) show estimated emissions for specific processes.

In 1970, stationary source fuel combustion contributed 25 percent of the total, and in 1990, contributed 23 percent. In 1990, 62 percent of the TP emissions from stationary fuel combustion sources originated from wood burning, compared to 14 percent in 1970. Today, wood stoves, wood furnaces and fireplaces in residential homes account for 91 percent of the TP emissions from wood burning.

Coal combustion by electric utilities has increased from an estimated 321 million tons in 1970 to 771 million tons in 1990 while TP emissions from electric utilities have decreased. Installation of improved control equipment is largely responsible for this reduction. New facilities constructed in the 1970s were required to meet New Source Performance Standards.

Comments on Particulate Emission Estimates

Particulate emission controls have been mostly effective in reducing emissions of large and intermediate size particles. The long-term trend in emissions of small particles is not known because only a few years of data are presently available. It is unlikely, however, that small particle emissions (PM-10) have been reduced to the same extent that total particulate emissions have been reduced. It should be noted that some small particles may form in the atmosphere through various chemical and physical processes. These particles are not included in the TP emission estimates.

5.2 Sulfur Oxides

1940 - 1970

From 1940 to 1970, SO_x emissions increased 61 percent as a result of increased consumption of fossil fuels. By 1970, coal combustion accounted for 82 percent of total SO_x emissions from all stationary fuel combustion sources. Emissions from industrial processes also increased, but to a lesser extent. SO_x emissions from other sources decreased, primarily as a result of the obsolescence of coal-fired locomotives and less coal refuse burning.

1970 - 1990

Since 1970, total SO_x emissions have declined about 25 percent as a result of the use of cleaner fuels with lower sulfur content, the use of flue gas desulfurization systems at some power plants, and the increased use of emission control devices by industry. In particular, SO_x emissions have been sharply reduced at nonferrous smelters. By-product recovery of sulfuric acid at these smelters has increased since 1970 resulting in recovered sulfuric acid not being emitted in the form of SO_x. In addition, new sulfuric acid manufacturing plants have been subject to New Source Performance Standards since 1972. As new plants are built or modified, they must achieve more stringent emission controls.

As shown in Figure 3, electric utilities account for most of the total SO_x emissions. From 1970 to 1990, coal consumption by electric utilities more than doubled, but total emissions decreased slightly as a result of coal cleaning and blending with lower sulfur coal. Flue gas desulfurization systems have been installed at new plants since the late 1970s and have been retrofitted on many existing plants. These systems have substantially reduced emissions compared to what they otherwise might have been. SO_x emissions from other fuel combustion sectors have also generally decreased, primarily due to less coal burning by industrial, commercial and residential consumers.

The theoretical 1990 national emission estimates shown in Table 8 for stationary fuel combustion sources are based on 1990 fuel consumption, fuel sulfur contents that represent 1970 average levels for fuel oil and an estimated average sulfur content of coal that would have been consumed if there were no changes in air pollution regulations since 1970. It is estimated that the average sulfur content of coal burned nationwide would have declined even without new air pollution regulations due to the greater use of cleaner coal from the Western U.S., which generally has a lower sulfur content than coal from the Eastern U.S. At the 1970 level of control, electric utility emissions would have increased about 49 percent since 1970. In reality, electric utility SO_x emissions decreased by 10 percent from 1970 to 1990.

Comments on SO_x Emission Estimates

SO_x emissions have been identified as precursors of acidic precipitation and deposition. To support Federal research activities on this subject, more detailed historical emissions estimates of SO_x have been developed. Interested readers may wish to review Reference 32, which contains state-level estimates of SO_x and NO_x emissions from 1900 through 1980 and by source category together with historic fuel consumption data.

5.3 Nitrogen Oxides

1940 - 1970

NO_x emissions are emitted mostly by stationary fuel combustion sources and by motor vehicles. From 1940 through 1970, NO_x emissions increased steadily as a result of increased natural gas combustion and an increase in gasoline consumption.

1970 - 1990

Table 8 shows that with the 1970 control level, national NO_x emissions would have been 40 percent greater than actual 1990 emissions. For electric utilities, New Source Performance Standards have helped reduce the growth in NO_x emissions even though NO_x emissions from electric utilities increased 66 percent from 1970 to 1990. For mobile sources, NO_x emissions have been controlled as a result of the Federal Motor Vehicle Control Program. Without this program, NO_x emissions from highway vehicles may have more than doubled. In reality, NO_x emissions from highway vehicles decreased 11 percent from 1970 to 1990.

5.4 Non-methane Volatile Organic Compounds

1940 - 1970

From 1940 through 1970, non-methane VOC emissions increased about 65 percent. Major increases in vehicular travel and industrial production were mostly responsible for this increase. Total VOC emissions from transportation sources almost doubled from 1940 to 1970. In 1940, residential fuel combustion and forest fires accounted for 32 percent of total national VOC emissions, but by 1970 their contribution had decreased to 4 percent.

1970 - 1990

Since 1970, total national VOC emissions have decreased as a result of motor vehicle emission controls and less open burning of solid waste. VOC emissions from gasoline and diesel powered highway vehicles decreased 44 percent from 1970 to 1990. Table 8 presents the theoretical 1990 emissions assuming 1970 levels of control.

Total national VOC emissions also have decreased since 1970 due to the substitution of water-based emulsified asphalts for asphalts liquified with petroleum distillates. This reduction is reflected in the decreased emissions reported for miscellaneous organic solvent use. Some of this decrease has been partially offset by increases in industrial process emissions.

In the early 1970s, VOC emissions from industrial processes would have increased due to higher production levels, particularly in petroleum refining, organic chemical production, and industrial uses of organic solvents. Emission control devices and process changes have helped limit the growth in emissions. Through the mid-1970s, emissions from petroleum product storage and marketing operations actually increased as a result of increased demand for petroleum products, especially motor gasoline. Since 1978, emissions from these sources have decreased as the result of more effective control measures.

Comments on Non-methane VOC Emission Estimates

VOC and NO_x are principal components in atmospheric chemical and physical reactions that form ozone and other photochemical oxidants. VOC species that contribute mostly to the formation of ozone are included in the total VOC emission estimates. Nonreactive compounds such as methane are not included. Biogenic sources of organic compounds, such as trees and other vegetation, are also not included at the present time. VOC from natural sources appears to exceed the amount of anthropogenic emissions according to recent research, but the extent to which biogenic sources contribute to oxidant formation has not been clearly established.

Historic emissions of non-methane VOC from anthropogenic sources have been estimated by state from 1900 to 1985 in support of Federal research activities under NAPAP[33], and by source category.

5.5 Carbon Monoxide

1940 - 1970

In 1940, highway vehicles contributed about 27 percent of CO emissions while residential combustion of fuel, forest fires, and miscellaneous burning contributed about 50 percent of the total CO emissions. From 1940 through 1970, emissions from all types of highway vehicles combined nearly tripled.

By 1970, highway vehicles accounted for 64 percent of the total CO emissions. Emissions from industrial processes increased from 1940 to 1970 by about 35 percent. The largest increase occurred in the petroleum refining sector, primarily as a result of increased refinery throughput to meet increased demand for gasoline and other distillate products.

1970 - 1990

Since 1970, highway vehicles have been the largest single contributing source of CO emissions. Figure 6 shows how the emissions from major highway vehicle subcategories have changed. The implementation of the Federal Motor Vehicle Control Program has helped reduce CO emissions since the early 1970s.

From 1970 through 1980, total vehicle miles travelled increased 36 percent, but because of controls on new vehicles, total CO emissions from highway vehicles actually decreased 25 percent. From 1980 through 1990 vehicle miles travelled increased about 35 percent, but as a result of pollution controls and the disappearance of older uncontrolled vehicles, CO emissions from highway vehicles actually decreased 38 percent during this period. Without the implementation of vehicle emission controls, CO emissions from highway vehicles would have increased more than threefold from 1970 to 1990.

CO emissions from stationary fuel combustion sources occur mainly in the residential sector. These emissions decreased in the mid-1970s as residential consumers converted from fuel oil to natural gas or electric heating. Part of this decrease has been offset by the increased use of residential wood stoves and fireplaces. In 1990, residential wood combustion accounted for about 10 percent of total national CO emissions.

CO emissions from other sources have also decreased. Emissions from solid waste disposal have decreased as the result of regulating or prohibiting burning of solid waste in many areas of the country. CO emissions from industrial processes have also declined since 1970 as a result of the obsolescence of certain high-polluting processes such as the manufacture of carbon black by the channel process, and as a result of installing more emission controls. Emissions from the burning of agricultural crop residues have also decreased since 1970 as a result of less burning.

5.6 Lead

1970 - 1990

Total national lead emissions have also decreased sharply as a result of the Federal Motor Vehicle Control Program. This program has resulted in the widespread use of catalytic converters on automobiles to help reduce NO_x, VOC, and CO emissions and the use of unleaded gasoline for vehicles with these converters. From 1970 through 1975, gasoline consumption increased 16 percent, but because of the decrease in the lead content of gasoline, lead emissions from highway vehicles decreased 24 percent. From 1975 to 1990, the percent of unleaded gasoline sales increased from 13 to over 90 percent, and the lead emissions from highway vehicles decreased about 99 percent (see Table A-6).

A major recent reduction in lead emissions occurred when the U.S. EPA required petroleum refiners to lower the lead content of leaded gasoline to 0.5 grams per gallon in 1985 and 0.1 grams per gallon in 1986. Previously, the lead content of leaded gasoline had been 1.1 grams per gallon or more.

In 1990, lead emissions from highway vehicles account for 29 percent of the total national lead emissions. Industrial processes account for 31 percent of the total. Solid waste disposal accounts for an additional 31 percent and stationary source fuel combustion accounts for the rest. These percentage contributions are substantially different from the contribution in 1970 when highway vehicles accounted for 77 percent of the total.

6.0 NATIONAL EMISSION PROJECTIONS

Emission projections are important for examining the potential combined effect of the Clean Air Act Amendments (CAAA) of 1990 and expected changes in the national economy and resulting pollution generating activity. Projections have been made for the years 2000 and 2010 using currently available information. The current emission projections for SO_x, NO_x, VOC and CO are described below together with basic assumptions.

The projections for each pollutant show a decrease in total national emissions from 1990 to 2000. The decreases are a result of the expected effect of the CAAA which imposes mandatory emission reductions on a broad range of source categories. These mandatory reductions are expected to more than offset increases due to assumed economic growth. Implementation by States of discretionary measures needed to meet ambient standards or progress requirements for VOC are accounted for.

In order to project emission trends it is necessary to predict economic growth, industrial activity, fuel consumption and other factors. Therefore future trends are speculative and there may be a significant level of uncertainty associated with them. Projected emission estimates will be updated periodically using the most recent information on actual activity by each source category. As new information becomes available emission trends will be updated and emission projections will be recalculated.

6.1 Future Trends in Sulfur Oxide Emissions

Table 9 presents the current estimates of future total national SO_x emissions, and SO_x emissions from electric utilities and other sources. The expected emission trends are shown in Figure 17. The estimated electric utility emissions are based on a model (AIRCOST-PC) which simulates emissions according to current and future emission standards and controls, electric utility generation capacity and future demand for electricity.[34] Electricity generation forecasts were obtained from the U.S. Department of Energy.[35] Nonutility SO_x emissions are based on the 1985 NAPAP emission inventory and earnings projections by source category as reported by the Bureau of Economic Analysis[36] and the estimated rate of retirement of existing sources.

Future SO_x emissions will be significantly affected by the CAAA of 1990 with a projected reduction of 10 million short tons (approximately 9.1 teragrams) from the 1980 emission level to be achieved by 2010. SO_x emissions from electric utilities will be subject to mandated reductions as part of a two phase program beginning in 1995. While the second phase of mandated reductions begins in 2000, the effect of various special phase-in provisions will result in higher emissions in the early 2000s, until by 2010 total allowable sulfur dioxide will be 8.9 million tons (approximately 8.1 teragrams). The acid rain title limits the total allowable tons of sulfur dioxide from the utility sector but leaves plant by plant compliance decisions to the industry. That is, acid rain control amendments will be implemented using a market-based emissions allowance trading system which allows utility managers to decide which combination of pollution control equipment, low sulfur fuel, energy conservation, emissions dispatching and emissions allowances they feel is suitable to ensure compliance with the primary prohibition against emitting sulfur dioxide in excess of the number of allowances held.

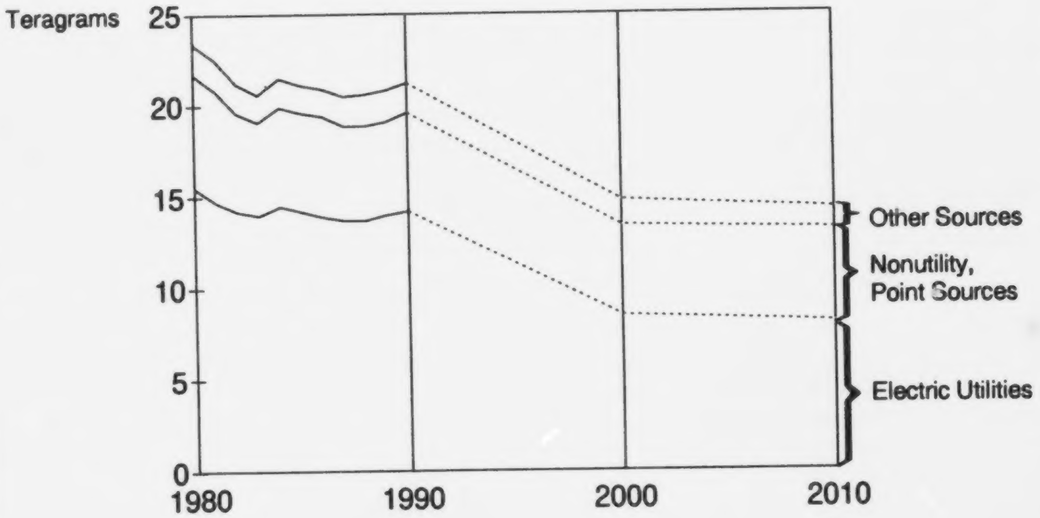
SO_x emissions from nonutility point sources have declined from 1980 levels due to reduced activity in steel production, nonferrous smelting and other heavy industrial processes which historically were major sources. Emission reductions in the CAAA were based on the assumption that net emission reductions, which occurred between 1980 and 1985, would not be offset by growth in future years. The projections presented here are based on that assumption. Because of the uncertainty associated with the emissions from these and other sources, the EPA will conduct a study of future industrial SO_x emissions.

Further reductions in SO_x emissions are expected after 1990 as a result of motor vehicle diesel fuel being limited to 0.05 percent sulfur (by weight). This limit is expected to produce about an 80 percent reduction in emissions per diesel-powered vehicle. Some of this reduction may be offset by the expected increase in diesel fuel consumption over the next 10 to 20 years.

TABLE 9. TOTAL NATIONAL SULFUR OXIDE EMISSIONS, 1980 TO 2010
(Teragrams/Year)

	1980	1990	2000	2010
Electric Utilities	15.5	14.2	8.5	8.1
Nonutility, Point Sources	6.2	5.4	4.9	5.1
Other Sources	1.7	1.6	1.4	1.1
Total	23.4	21.2	14.8	14.3

Figure 17. Projected Trend in SULFUR OXIDE Emissions, 1990 to 2010



6.2 Future Trends in Nitrogen Oxide Emissions

Table 10 presents the current estimates of future total NO_x emissions and NO_x emissions from highway vehicles, industrial sources, electric utilities and all other sources. These expected emission trends are shown in Figure 18. The projections account for the expected net effect of all provisions of the CAAA concerning NO_x. These include the NO_x emission limits prescribed for utility boilers under the acid rain provisions, the Tier I automobile tailpipe standards, and application of technology based requirements to nonutility boilers (generally greater than 100 tons/year) in ozone nonattainment areas and the Northeast Ozone Transport Region. The estimates do not fully incorporate new source review requirements such as offsets and lowest achievable emission rates in nonattainment areas, nor additional controls required based on attainment demonstration modeling. They also do not attempt to estimate the extent to which any areas might be exempted from NO_x stationary source controls under Section 182(f).

Projections of NO_x emissions from highway vehicles are based on projected vehicle miles travelled and MOBILE4.1 emission factors. These emission factors reflect current emission control standards and Tier I motor vehicle emission standards of the CAAA. (Tier II standards are not reflected because these are discretionary.) As a result of these standards, NO_x emissions from highway vehicles are expected to decrease by almost 50 percent from 1990 to 2000.

By 2000, all electric utility units with capacities greater than 25 megawatts are expected to meet new emission limits imposed by the CAAA. Also, new or modified electric power units will be subject to revised performance standards. As a result, NO_x emissions from electric utilities are expected to decrease by 16 percent in the next ten years. The analysis for utilities was performed under the assumption that low NO_x combustion technology would be employed to meet the NO_x provisions of Title IV. The 6.1 teragram estimate for electric utilities in 2000 is approximately 1.8 teragrams (2 million short tons) less than what would have been emitted by utilities without controls implemented as a result of the CAAA of 1990.

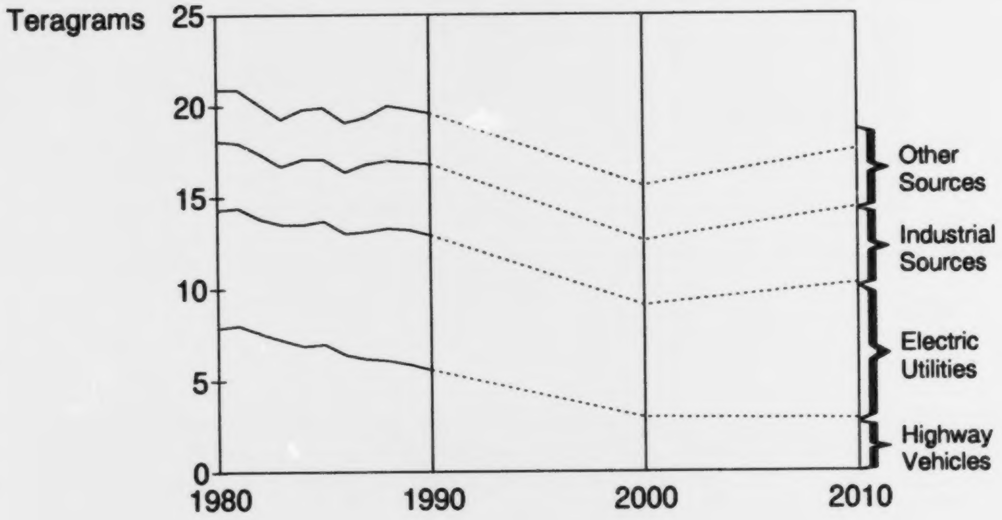
Estimates of future NO_x emissions from industrial sources are based on state-level growth factors and the expected application of reasonable available control technology where required. As a result, a 10 percent reduction is expected in NO_x emissions from industrial sources from 1990 to 2000. This reduction may be more than offset by increases in emissions between 2000 and 2010. The future trend of stationary source NO_x emissions is presently uncertain because it is not known whether ozone nonattainment areas will be exempt from the proposed new source review policy that requires lowest achievable emission reductions and offsets for new major sources.

TABLE 10. TOTAL NATIONAL NITROGEN OXIDE EMISSIONS, 1980 TO 2010
(Teragrams/Year)

	1980	1990	2000	2010
Electric Utilities	6.4	7.3	6.1	7.4
Industrial Sources *	3.8	3.9	3.5	4.1
Highway Vehicles	7.9	5.6	3.0	2.9
Other	2.8	2.8	3.0	3.2
Total	20.9	19.6	15.6	17.6

* Includes industrial fuel combustion and processes.

Figure 18. Projected Trend in NITROGEN OXIDE Emissions, 1990 to 2010



6.3 Future Trends in Non-methane Volatile Organic Compound Emissions

Table 11 presents the current estimates of future total national VOC emissions and VOC emissions from highway vehicles. The expected emission trends are shown in Figure 19. These estimates are also based on the Emission Reduction and Cost Analysis Model (ERCAM)[37] which has been used to analyze costs and benefits of the nonattainment and motor vehicle provisions in the CAAA of 1990 in addition to projecting NO_x emissions. The estimates are based on presumed growth rates in population, industrial activity, and vehicle miles travelled. It is assumed that mandatory emission control measures specified in the CAAA, such as tailpipe emission standards and prescribed emission controls for point sources, will be implemented. It is also assumed that states will meet the minimum emission control requirements and reductions as specified by the CAAA in order to meet the National Ambient Air Quality Standards for ozone. In reality, states may exceed the minimum requirements, and therefore, future emissions may be overestimated.

Table 11 shows a 27 percent decrease in total national VOC emissions from 1990 to 2000. This decrease is largely due to an expected 65 percent reduction in emissions from highway vehicles as a result of continued fleet turnover and additional emission controls despite an expected 25 percent increase in total vehicle miles travelled over this time period.

From 2000 to 2010, the estimates are substantially more uncertain, but currently indicate that total emissions will remain stable. Growth and development in attainment areas (areas meeting the National Ambient Air Quality Standards for ozone), is expected to result in increased emissions. This increase is expected to offset continued declines in nonattainment area emissions, especially those where additional reductions will be needed after 2000.

TABLE 11. TOTAL NATIONAL NON-METHANE VOLATILE ORGANIC COMPOUND EMISSIONS, 1980 TO 2010
(Teragrams/Year)

	1980	1990	2000	2010
Highway Vehicles	7.7	5.1	1.6	1.6
All Other Sources	14.9	13.6	11.6	11.6
Total	22.6	18.7	13.2	13.2

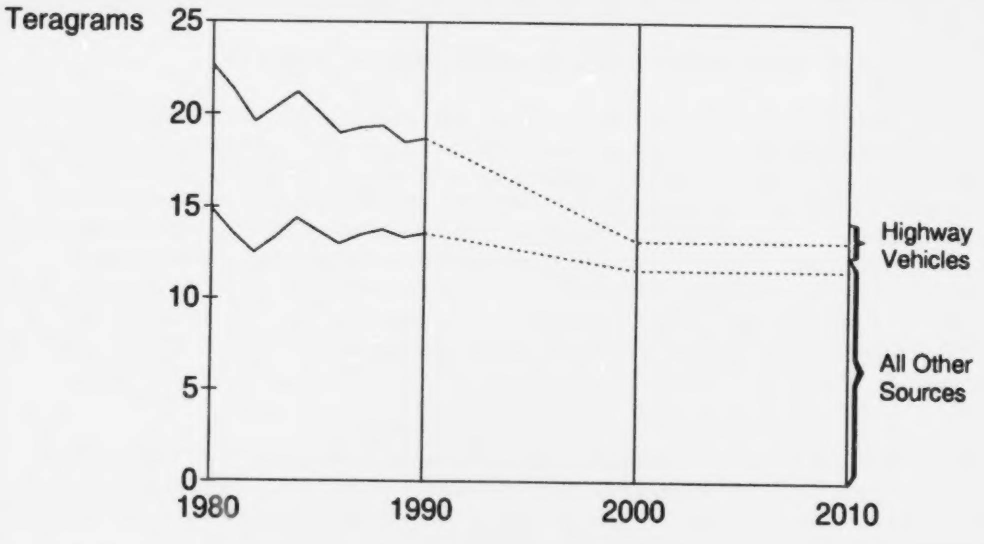


Figure 19. Projected Trend in NON-METHANE VOLATILE ORGANIC COMPOUND Emissions, 1990 to 2010

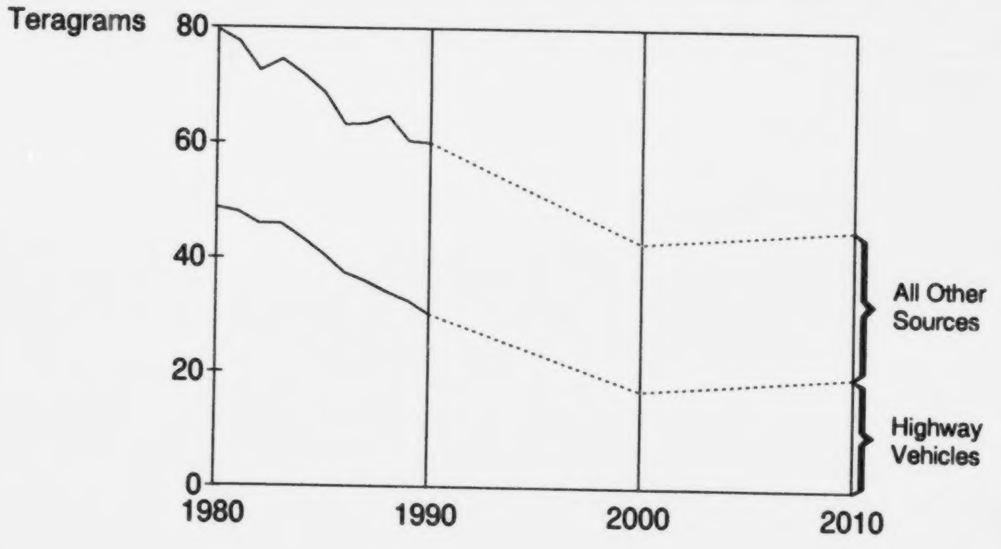
6.4 Future Trends in Carbon Monoxide Emissions

Table 12 presents the current estimates of future total national CO emissions and CO emissions from highway vehicles. The expected emission trends are shown in Figure 20. These estimates are also based on ERCAM. The projections show a 43 percent decrease by the year 2000 in total CO emissions from highway vehicles as a result of continued fleet turnover and new measures such as enhanced automobile inspection and maintenance programs, and the expected use of oxygenated fuels in CO nonattainment areas.

TABLE 12. TOTAL NATIONAL CARBON MONOXIDE EMISSIONS, 1980 TO 2010
(Teragrams/Year)

	1980	1990	2000	2010
Highway Vehicles	48.7	30.3	17.1	19.8
All Other Sources	30.9	29.8	25.8	25.6
Total	79.6	60.1	42.9	45.4

Figure 20. Projected Trend in CARBON MONOXIDE Emissions, 1990 to 2010



7.0 SEASONAL EMISSION PROJECTIONS

A comparison of peak ozone season VOC emissions and annual average VOC emissions is shown in Table 13. The peak ozone season is generally the summer months (June, July and August) when ambient temperatures are generally high and contribute to increased formation of ozone in the lower atmosphere. The 1990 CAAA measure progress toward attaining the ozone National Ambient Air Quality Standards in terms of decreases in peak ozone season VOC emissions. VOC emissions are a principal precursor to ozone which is commonly referred to as smog. Table 13 shows the 1987 base year emissions and projected emissions for the year 2000 and 2010. The 1987 base year was chosen since it is the mid-point of the ambient ozone concentration data used to determine the nonattainment status of different areas of the country.

Table 13 shows that on a daily basis, peak ozone season VOC emissions are greater than annual average emissions. Evaporative VOC emissions from motor vehicles increase with temperature producing emissions during the ozone season that are higher than annual average emissions. Nonmotor vehicle VOC emissions are lower during the ozone season than average annual emissions due to decreases in residential wood burning, which is typically associated with wintertime heating. Projection year differences in total VOC emissions narrow with time as the contribution of motor vehicle emissions decreases due to more stringent emission controls. Control measures expected to reduce evaporative motor vehicle VOC emissions include the new Federal evaporative test procedure, less volatile gasoline, enhanced inspection procedures, and new vehicle refueling controls.

Table 14 provides a comparison of peak ozone season and annual average NO_x emissions. Peak ozone season NO_x emissions are lower than annual average emissions because motor vehicle NO_x emissions decrease with increasing temperature. This analysis does not attempt to capture seasonal variations in point source emissions. Nonmotor vehicle emissions shown in Table 14 therefore are identical for ozone season and annual average days. While demand for electricity may be higher in the summer than in other seasons, and can produce corresponding peaks in emissions from electric utilities, these peak demand periods can vary significantly by day and by location. Thus, the values shown in Table 14 should not be considered representative of emissions in any specific area. There is no reason to expect that industrial NO_x emissions will vary significantly by season on the national level.

Table 13
Comparison of Peak Ozone Season and Annual Average VOC Emissions
(Gigagrams/Day)

	Peak Ozone Season			Annual Average		
	1987	2000	2010	1987	2000	2010
Motor Vehicles	24.5	7.6	7.3	15.9	4.3	4.4
All Other Sources	35.4	29.4	29.7	37.3	31.8	31.8
Total	59.9	37.0	37.0	53.2	36.1	36.2

Table 14
Comparison of Peak Ozone Season and Annual Average NO_x Emissions
(Gigagrams/Day)

	Peak Ozone Season			Annual Average		
	1987	2000	2010	1987	2000	2010
Motor Vehicles	14.9	7.8	7.4	16.9	8.2	7.9
All Other Sources	36.5	34.5	40.3	36.5	34.5	40.3
Total	51.4	42.3	47.7	53.4	42.7	48.2

Notes: The 1987 emission estimates are based on National Air Pollutant Emission Estimates 1940-1989, EPA-450/4-91-004, March 1991. These estimates were adjusted to reflect peak ozone season (generally June through August) conditions.

The projection year VOC emissions are from ERCAM-VOC model results. These results are based on a September, 1991 analysis of the 1990 CAAA.

The projection year NO_x emissions are from a September, 1991 analysis of the 1990 CAAA.

* Emission estimates for the years 2000 and 2010 reflect additional reductions needed for areas to meet estimated 3 percent reductions or attainment targets. More reductions may be needed. Some may come from NO_x after 1996.

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APPENDIX A - NATIONAL EMISSIONS BY SOURCE CATEGORY

TABLE A-1. NATIONAL EMISSIONS ESTIMATES OF TOTAL PARTICULATE MATTER
(Teragrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Transportation														
Highway Vehicles	0.9	1.0	1.1	1.1	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.2	1.3	1.3
Aircraft	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Railroads	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vessels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Off Highway	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Transportation Total	1.2	1.3	1.4	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.5
Stationary Source Fuel Combustion														
Electric Utilities	2.3	1.5	1.0	0.8	0.7	0.6	0.6	0.6	0.4	0.4	0.4	0.4	0.4	0.4
Industrial	1.6	0.6	0.5	0.5	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.3
Commercial-Institutional	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Residential	0.6	0.5	0.9	1.0	1.0	1.1	1.1	1.2	1.0	1.0	1.0	1.0	1.1	1.0
Fuel Combustion Total	4.6	2.8	2.5	2.4	2.3	2.2	2.0	2.1	1.8	1.8	1.8	1.7	1.8	1.7
Industrial Processes	10.5	5.2	3.8	3.3	3.0	2.6	2.4	2.8	2.8	2.6	2.5	2.7	2.7	2.8
Solid Waste Disposal														
Incineration	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Open Burning	0.7	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Solid Waste Total	1.1	0.6	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Miscellaneous														
Forest Fires	0.7	0.6	0.8	1.0	0.8	0.6	1.0	0.8	0.9	0.7	0.8	1.2	0.8	1.1
Other Burning	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Miscellaneous Organic Solvent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous Total	1.1	0.7	0.9	1.1	0.9	0.7	1.1	0.9	1.0	0.8	0.9	1.3	0.9	1.2
Total of All Sources	18.5	10.6	8.9	8.5	8.0	7.1	7.1	7.4	7.2	6.7	6.9	7.5	7.2	7.5

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE A-2. NATIONAL EMISSIONS ESTIMATES OF SULFUR OXIDES
(Teragrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Transportation														
Highway Vehicles	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6
Aircraft	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Railroads	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vessels	0.2	0.1	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Other Off Highway	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Transportation Total	0.6	0.7	0.9	0.9	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.9
Stationary Source Fuel Combustion														
Electric Utilities	15.8	16.6	16.0	15.5	14.7	14.2	14.0	14.5	14.2	13.9	13.7	13.7	14.0	14.2
Industrial	4.1	2.7	2.7	2.4	2.3	2.3	2.0	2.2	2.2	2.3	2.2	2.1	2.1	2.3
Commercial-Institutional	0.9	0.7	0.6	0.7	0.6	0.6	0.4	0.5	0.4	0.5	0.5	0.5	0.4	0.4
Residential	0.5	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.3
Fuel Combustion Total	21.3	20.2	19.5	18.7	17.8	17.3	16.7	17.4	17.0	16.9	16.6	16.6	16.8	17.1
Industrial Processes	6.4	5.0	4.4	3.8	3.8	3.1	3.1	3.2	3.2	3.2	3.0	3.1	3.0	3.1
Solid Waste Disposal														
Incineration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Burning	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solid Waste Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous														
Forest Fires	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Burning	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous Organic Solvent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous Total	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total of All Sources	28.4	25.8	24.8	23.4	22.5	21.2	20.6	21.5	21.1	20.9	20.5	20.6	20.8	21.2

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE A-3. NATIONAL EMISSIONS ESTIMATES OF NITROGEN OXIDES
(Teragrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Transportation														
Highway Vehicles	6.3	7.6	8.0	7.9	8.0	7.6	7.2	6.9	7.0	6.4	6.2	6.1	5.9	5.6
Aircraft	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Railroads	0.6	0.7	0.8	0.8	0.7	0.7	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5
Vessels	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Other Off Highway	0.8	0.9	1.1	1.0	0.9	0.9	0.9	1.0	1.0	1.1	1.0	1.1	1.1	1.1
Transportation Total	8.0	9.3	10.1	9.8	9.9	9.4	8.9	8.8	8.9	8.3	8.1	8.1	7.9	7.5
Stationary Source Fuel Combustion														
Electric Utilities	4.4	5.2	6.1	6.4	6.4	6.2	6.3	6.6	6.7	6.6	6.9	7.2	7.3	7.3
Industrial	3.9	3.5	3.6	3.1	3.0	3.1	2.7	3.0	2.8	2.8	3.1	3.1	3.1	3.3
Commercial-Institutional	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Residential	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Fuel Combustion Total	9.1	9.3	10.5	10.1	10.0	9.8	9.6	10.2	10.2	10.0	10.5	10.9	11.1	11.2
Industrial Processes	0.7	0.7	0.7	0.7	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Solid Waste Disposal														
Incineration	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Burning	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Solid Waste Total	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Miscellaneous														
Forest Fires	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.2	0.3	0.2	0.2
Other Burning	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous Organic Solvent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous Total	0.3	0.2	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.3
Total of All Sources	18.5	19.6	21.5	20.9	20.9	20.0	19.4	19.8	19.9	19.1	19.4	20.0	19.8	19.6

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE A-4. NATIONAL EMISSIONS ESTIMATES OF NON-METHANE VOLATILE ORGANIC COMPOUNDS

(Teragrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Transportation														
Highway Vehicles	9.1	7.5	6.8	7.7	7.7	7.1	7.0	6.8	6.4	6.0	5.8	5.6	5.1	5.1
Aircraft	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Railroads	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vessels	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.5	0.5	0.5	0.5
Other Off Highway	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Transportation Total	10.3	8.8	8.0	9.0	8.9	8.3	8.2	8.1	7.6	7.2	7.1	6.9	6.4	6.4
Stationary Source Fuel Combustion														
Electric Utilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Industrial	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Commercial-Institutional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Residential	0.4	0.4	0.7	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7
Fuel Combustion Total	0.6	0.6	0.9	0.9	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9
Industrial Processes	8.9	8.3	9.9	9.2	8.3	7.5	7.9	8.9	8.5	8.0	8.3	8.1	8.1	8.1
Solid Waste Disposal														
Incineration	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Open Burning	1.3	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Solid Waste Total	1.8	0.9	0.7	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Miscellaneous														
Forest Fires	0.7	0.5	0.8	0.9	0.8	0.6	1.0	0.8	0.9	0.6	0.8	1.2	0.8	1.1
Other Burning	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Miscellaneous Organic Solvent	2.3	1.9	2.0	1.9	1.6	1.5	1.6	1.8	1.5	1.5	1.5	1.6	1.6	1.5
Miscellaneous Total	3.3	2.5	2.9	2.9	2.4	2.1	2.7	2.6	2.5	2.2	2.4	2.9	2.5	2.7
Total of All Sources	25.0	21.1	22.4	22.6	21.3	19.6	20.4	21.2	20.1	19.0	19.3	19.4	18.5	18.7

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE A-5. NATIONAL EMISSIONS ESTIMATES OF CARBON MONOXIDE

(Teragrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Transportation														
Highway Vehicles	65.3	57.2	51.9	48.7	48.0	45.9	45.9	43.5	40.7	37.5	36.0	34.1	32.7	30.3
Aircraft	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.0	1.1	1.1
Railroads	0.3	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Vessels	1.2	1.4	1.4	1.4	1.4	1.4	1.4	1.7	1.4	1.5	1.6	1.6	1.7	1.7
Other Off Highway	6.8	5.4	4.5	4.7	4.7	4.4	3.9	4.2	4.5	4.4	4.4	4.2	4.4	4.4
Transportation Total	74.4	65.0	59.1	56.1	55.4	52.9	52.4	50.6	47.9	44.6	43.3	41.2	40.0	37.6
Stationary Source Fuel Combustion														
Electric Utilities	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Industrial	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7
Commercial-Institutional	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Residential	3.5	3.3	5.7	6.4	6.7	7.3	7.2	7.3	6.5	6.6	6.6	6.6	6.7	6.4
Fuel Combustion Total	4.5	4.3	6.7	7.4	7.7	8.2	8.2	8.3	7.5	7.5	7.6	7.6	7.8	7.5
Industrial Processes	9.0	6.9	7.1	6.3	5.9	4.4	4.3	4.7	4.4	4.2	4.3	4.6	4.6	4.7
Solid Waste Disposal														
Incineration	2.7	1.8	1.3	1.2	1.2	1.1	1.0	1.0	1.1	0.9	0.9	0.9	0.9	0.9
Open Burning	3.7	1.3	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8
Solid Waste Total	6.4	3.1	2.3	2.2	2.1	2.0	1.9	1.9	1.9	1.8	1.8	1.7	1.7	1.7
Miscellaneous														
Forest Fires	5.1	4.0	5.8	6.9	5.8	4.3	7.1	5.7	6.5	4.5	5.8	8.9	5.8	8.1
Other Burning	2.1	0.8	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Miscellaneous Organic Solvent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous Total	7.2	4.8	6.5	7.6	6.4	4.9	7.8	6.4	7.1	5.1	6.4	9.5	6.3	8.6
Total of All Sources	101.4	84.1	81.7	79.6	77.5	72.5	74.5	71.9	68.7	63.2	63.4	64.7	60.4	60.1

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE A-6. NATIONAL EMISSIONS ESTIMATES OF LEAD
(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Transportation														
Highway Vehicles	156.0	118.1	90.8	56.4	43.5	44.4	38.7	32.6	14.5	3.3	2.8	2.4	2.0	2.0
Off Highway	7.6	4.5	3.8	3.0	3.0	2.5	2.1	2.1	0.2	0.2	0.2	0.2	0.2	0.2
Transportation Total	163.6	122.6	94.6	59.4	46.5	47.0	40.8	34.7	14.7	3.5	3.0	2.6	2.2	2.2
Stationary Source Fuel Combustion														
Electric Utilities	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Industrial	9.3	9.1	4.8	3.8	2.7	1.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Commercial-Institutional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Residential	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fuel Combustion Total	9.6	9.3	4.9	3.9	2.8	1.7	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Industrial Processes	23.9	10.3	5.2	3.6	3.0	2.7	2.4	2.3	2.3	1.9	1.9	2.0	2.3	2.2
Solid Waste Disposal	6.7	4.8	4.0	3.7	3.7	3.1	2.7	2.7	2.6	2.6	2.6	2.5	2.3	2.2
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total of All Sources	203.8	147.0	108.7	70.6	56.0	54.5	46.6	40.2	20.1	8.4	8.0	7.6	7.2	7.1

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE A-7. NATIONAL EMISSIONS ESTIMATES OF PM-10 (Teragrams/Year)

Source Category	1985	1986	1987	1988	1989	1990
Transportation						
Highway Vehicles	1.1	1.1	1.1	1.176	1.2	1.2
Aircraft	0.1	0.1	0.1	0.1	0.1	0.1
Railroads	0.0	0.0	0.0	0.0	0.0	0.0
Vessels	0.0	0.0	0.0	0.0	0.0	0.0
Other Off Highway	0.1	0.1	0.1	0.1	0.1	0.1
Transportation Total	1.3	1.3	1.3	1.4	1.5	1.5
Stationary Source Fuel Combustion						
Electric Utilities	0.0	0.0	0.0	0.0	0.0	0.0
Industrial	0.1	0.1	0.1	0.1	0.1	0.1
Commercial-Institutional	0.0	0.0	0.0	0.0	0.0	0.0
Residential	1.0	1.0	1.0	1.0	1.0	1.0
Fuel Combustion Total	1.1	1.1	1.1	1.1	1.1	1.1
Industrial Processes	2.7	2.5	2.4	2.6	2.6	2.7
Solid Waste Disposal						
Incineration	0.1	0.0	0.0	0.0	0.0	0.0
Open Burning	0.2	0.2	0.2	0.2	0.2	0.2
Solid Waste Total	0.3	0.2	0.2	0.2	0.2	0.2
Miscellaneous						
Forest Fires	0.6	0.5	0.6	0.9	0.6	0.8
Other Burning	0.1	0.1	0.1	0.1	0.1	0.1
Miscellaneous Organic Solvent	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous Total	0.7	0.5	0.7	1.0	0.7	0.9
Total of All Sources	6.0	5.6	5.8	6.3	6.1	6.4

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

APPENDIX B - NATIONAL EMISSIONS BY SUBCATEGORY

TABLE B-1. EMISSIONS OF TOTAL PARTICULATE MATTER FROM TRANSPORTATION SOURCES

(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Highway Vehicles														
Gasoline-powered														
Passenger cars	610	680	620	570	540	560	550	550	536	539	560	592	617	624
Light trucks - 1	80	100	90	90	90	80	90	90	102	110	122	126	132	133
Light trucks - 2	20	30	70	70	70	70	70	70	69	68	70	73	77	77
Heavy duty vehicles	60	50	60	60	60	50	50	50	46	40	40	44	46	47
Motorcycles	4	8	8	7	5	4	4	4	3	3	4	4	4	4
Total - Gasoline	774	868	848	797	765	764	764	764	756	760	796	840	876	885
Diesel-powered														
Passenger cars	0	1	5	9	10	20	20	20	19	18	16	13	11	11
Light trucks	0	0	1	3	5	5	5	6	4	3	3	4	4	4
Heavy duty vehicles	130	180	230	250	280	270	250	270	340	313	323	358	367	369
Total - Diesel	130	181	236	262	295	295	275	296	363	335	342	375	382	384
Highway Vehicle Total	904	1,049	1,084	1,059	1,060	1,059	1,039	1,060	1,119	1,095	1,138	1,215	1,258	1,269
Aircraft	100	80	70	70	70	70	80	80	87	85	78	78	79	79
Railroads	60	50	60	50	50	50	40	40	37	35	36	37	38	32
Vessels	40	30	30	30	30	30	30	30	28	28	30	30	31	32
Farm Machinery	40	50	70	60	60	60	60	60	71	73	69	78	70	74
Construction Machinery	10	10	20	20	20	20	20	20	19	22	20	21	21	22
Industrial Machinery	20	20	30	20	20	20	20	20	14	14	14	14	17	13
Other Off-highway Vehicles	4	5	5	5	5	5	5	5	5	5	5	5	5	5
Transportation Total	1,178	1,294	1,369	1,314	1,315	1,314	1,294	1,315	1,379	1,356	1,388	1,477	1,519	1,524

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE B-2. EMISSIONS OF SULFUR OXIDES FROM TRANSPORTATION SOURCES

(Gigagrams/Year)

Source Category	**1970**	**1975**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Highway Vehicles														
Gasoline-powered														
Passenger cars	120	130	150	140	140	150	160	160	161	167	174	184	192	194
Light trucks - 1	20	30	30	30	30	30	30	40	42	48	53	54	57	58
Light trucks - 2	6	9	20	20	20	20	20	20	25	25	25	26	28	28
Heavy duty vehicles	10	10	10	10	10	10	10	10	12	10	10	11	12	12
Motorcycles	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Total - Gasoline	156	179	211	201	200	210	220	230	240	250	263	276	288	291
Diesel-powered														
Passenger cars	0	0	3	5	10	10	10	10	11	10	9	8	6	6
Light trucks	0	0	1	2	3	3	3	4	2	2	2	1	2	2
Heavy duty vehicles	100	140	180	200	220	210	200	210	270	248	256	284	291	293
Total - Diesel	100	140	184	207	233	223	213	224	283	261	267	293	300	301
Highway Vehicle Total	256	319	395	408	433	433	433	454	523	511	530	569	588	593
Aircraft	10	10	10	10	10	10	10	10	15	16	17	17	17	19
Railroads	130	110	120	120	110	110	80	90	84	80	82	85	85	72
Vessels	150	140	250	270	250	200	180	190	180	177	178	179	184	180
Farm Machinery	30	30	50	40	40	40	40	40	48	49	46	53	47	50
Construction Machinery	10	20	20	20	20	20	20	20	20	23	20	22	21	22
Industrial Machinery	20	20	20	20	20	10	20	20	13	12	13	13	16	12
Other Off-highway Vehicles	1	1	1	1	1	1	1	1	2	2	2	2	2	2
Transportation Total	607	650	866	889	884	824	784	825	884	869	887	938	960	949

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE B-3. EMISSIONS OF NITROGEN OXIDES FROM TRANSPORTATION SOURCES

(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Highway Vehicles														
Gasoline-powered														
Passenger cars	3,980	4,520	4,190	3,880	3,670	3,630	3,410	3,280	2,955	2,763	2,600	2,503	2,342	2,168
Light trucks - 1	510	610	660	670	720	650	670	670	691	687	692	646	632	588
Light trucks - 2	220	320	550	540	590	520	540	510	490	456	421	396	375	337
Heavy duty vehicles	500	470	400	380	370	320	320	290	292	242	237	255	260	254
Motorcycles	4	8	10	10	10	10	10	10	9	10	10	11	11	11
Total - Gasoline	5,214	5,928	5,810	5,480	5,360	5,130	4,950	4,760	4,438	4,158	3,960	3,810	3,621	3,359
Diesel-powered														
Passenger cars	0	1	8	10	20	30	30	30	33	31	28	23	18	18
Light trucks	0	0	2	6	10	10	10	10	6	6	6	7	7	6
Heavy duty vehicles	1,130	1,640	2,180	2,360	2,610	2,420	2,160	2,130	2,555	2,194	2,181	2,302	2,293	2,219
Total - Diesel	1,130	1,641	2,190	2,376	2,640	2,460	2,200	2,170	2,594	2,231	2,215	2,332	2,318	2,243
Highway Vehicle Total	6,344	7,569	8,000	7,856	8,000	7,590	7,150	6,930	7,032	6,389	6,174	6,142	5,939	5,602
Aircraft	110	100	120	110	110	110	110	120	129	138	132	131	131	136
Railroads	640	660	750	750	710	660	540	580	540	520	528	547	548	468
Vessels	90	120	180	150	190	160	170	180	187	199	214	221	226	238
Farm Machinery	400	430	560	460	480	470	460	500	565	574	543	603	549	574
Construction Machinery	180	190	230	230	200	200	200	210	246	283	255	278	268	283
Industrial Machinery	220	240	260	260	240	220	230	240	204	191	195	193	245	181
Other Off-highway Vehicles	10	10	10	10	10	10	10	10	12	12	13	13	13	13
Transportation Total	7,994	9,319	10,110	9,826	9,940	9,420	8,870	8,770	8,915	8,308	8,053	8,127	7,918	7,494

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE B-4. EMISSIONS OF NON-METHANE VOLATILE ORGANIC COMPOUNDS FROM TRANSPORTATION SOURCES

(Gigagrams/Year)

Source Category	**1970**	**1975**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Highway Vehicles														
Gasoline-powered														
Passenger cars	6,770	5,380	4,400	5,175	4,904	4,736	4,624	4,398	4,074	3,908	3,776	3,630	3,384	3,335
Light trucks - 1	920	850	830	966	1,058	938	983	941	960	910	924	888	823	815
Light trucks - 2	400	440	710	750	877	724	761	745	717	665	632	594	516	482
Heavy duty vehicles	790	580	500	523	540	456	428	463	388	299	290	297	284	296
Motorcycles	80	160	140	106	80	59	54	52	40	38	39	38	35	36
Total - Gasoline	8,960	7,410	6,580	7,520	7,459	6,913	6,850	6,599	6,179	5,820	5,661	5,447	5,042	4,963
Diesel-powered														
Passenger cars	0	0	2	4	5	5	6	7	8	8	7	6	6	5
Light trucks	0	0	1	2	2	2	2	2	2	2	2	2	2	2
Heavy duty vehicles	100	130	180	202	220	203	191	192	209	178	172	175	73	165
Total - Diesel	100	130	183	208	227	210	199	201	219	188	181	183	81	172
Highway Vehicle Total	9,060	7,540	6,763	7,728	7,686	7,123	7,049	6,800	6,398	6,008	5,842	5,630	5,123	5,136
Aircraft	250	190	180	180	160	160	170	170	186	191	187	186	188	193
Railroads	160	160	180	180	170	160	130	140	131	126	128	132	133	113
Vessels	330	400	420	400	430	410	420	510	415	445	466	482	495	499
Farm Machinery	250	220	220	190	180	180	160	190	211	203	192	195	185	192
Construction Machinery	40	30	40	40	40	30	30	30	42	47	48	50	51	55
Industrial Machinery	120	80	80	80	100	90	80	70	65	63	66	66	73	65
Other Off-highway Vehicles	110	160	160	170	170	170	160	160	161	160	163	164	166	158
Transportation Total	10,320	8,780	8,043	8,968	8,936	8,323	8,199	8,070	7,607	7,243	7,092	6,905	6,412	6,410

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE B-5. EMISSIONS OF CARBON MONOXIDE FROM TRANSPORTATION SOURCES
(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Highway Vehicles														
Gasoline-powered														
Passenger cars	49,090	41,430	34,450	31,850	30,160	30,150	29,510	27,790	25,409	23,650	22,531	21,219	20,198	18,571
Light trucks - 1	5,800	5,730	5,960	5,810	6,370	5,760	6,190	6,050	6,279	6,059	6,103	5,769	5,677	5,408
Light trucks - 2	2,070	2,450	4,340	4,210	4,700	4,220	4,610	4,450	4,329	4,036	3,793	3,539	3,363	3,072
Heavy duty vehicles	7,810	6,610	6,170	5,870	5,780	4,910	4,720	4,380	3,749	2,918	2,797	2,735	2,588	2,379
Motorcycles	260	540	490	370	280	200	190	170	128	124	126	121	122	122
Total - Gasoline	65,030	56,760	51,410	48,110	47,290	45,240	45,220	42,840	39,894	36,787	35,349	33,384	31,948	29,553
Diesel-powered														
Passenger cars	0	0	5	8	10	10	20	20	17	17	15	13	11	11
Light trucks	0	0	1	3	6	6	5	3	4	4	3	4	4	4
Heavy duty vehicles	300	390	530	610	700	680	650	650	769	675	682	719	730	715
Total - Diesel	300	390	536	621	716	696	675	673	790	695	700	736	745	729
Highway Vehicle Total	65,330	57,150	51,946	48,731	48,006	45,936	45,895	43,513	40,684	37,482	36,050	34,119	32,692	30,282
Aircraft	900	880	990	990	960	950	980	1,010	1,086	1,082	1,062	1,048	1,067	1,078
Railroads	250	240	270	270	250	240	190	200	190	183	186	193	193	164
Vessels	1,150	1,360	1,420	1,380	1,440	1,390	1,410	1,700	1,396	1,498	1,565	1,617	1,662	1,670
Farm Machinery	3,570	2,930	2,240	2,040	1,880	1,780	1,470	1,900	2,117	1,914	1,828	1,645	1,640	1,697
Construction Machinery	580	370	370	460	370	320	260	250	414	451	524	526	558	622
Industrial Machinery	1,780	1,060	820	1,110	1,330	1,190	1,040	900	848	839	877	882	937	888
Other Off-highway Vehicles	840	990	1,080	1,100	1,150	1,130	1,140	1,130	1,153	1,169	1,190	1,194	1,224	1,210
Transportation Total	74,400	64,980	59,136	56,081	55,386	52,936	52,385	50,603	47,887	44,616	43,281	41,222	39,974	37,611

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE B-6. EMISSIONS OF PM-10 FROM TRANSPORTATION SOURCES
(Gigagrams/Year)

Source Category	1985	1986	1987	1988	1989	1990
Highway Vehicles						
Gasoline-powered						
Passenger cars	506	514	536	566	590	596
Light trucks - 1	96	106	117	121	127	128
Light trucks - 2	62	61	63	66	69	70
Heavy duty vehicles	46	40	40	44	46	47
Motorcycles	3	3	4	4	4	4
Total - Gasoline	714	725	759	801	835	844
Diesel-powered						
Passenger cars	19	18	16	13	11	11
Light trucks	4	3	3	4	4	4
Heavy duty vehicles	340	313	323	358	367	369
Total - Diesel	363	334	342	375	382	384
Highway Vehicle Total	1,076	1,059	1,101	1,176	1,218	1,228
Aircraft	75	80	77	77	79	78
Railroads	37	35	36	37	37	32
Vessels	16	16	17	17	17	17
Farm Machinery	69	71	67	76	69	72
Construction Machinery	19	21	19	21	20	21
Industrial Machinery	14	13	13	13	17	12
Other Off-highway Vehicles	4	4	4	4	4	3
Transportation Total	1,309	1,300	1,334	1,422	1,461	1,464

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE B-7. EMISSIONS OF TOTAL PARTICULATE MATTER FROM FUEL COMBUSTION SOURCES

(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Coal														
Electric Utilities	2,220	1,420	860	720	640	490	510	550	392	387	369	350	354	357
Industrial	1,300	360	250	250	280	220	110	110	120	93	84	83	84	105
Commercial-Institutional	40	40	30	30	30	40	20	20	19	19	17	18	14	16
Residential	80	20	10	10	10	20	20	20	15	15	18	18	15	16
Coal Total	3,640	1,840	1,150	1,010	960	770	660	700	547	513	487	469	466	493
Fuel Oil														
Electric Utilities	110	120	120	100	90	70	60	50	38	55	46	58	60	58
Industrial	80	70	70	60	50	50	30	40	36	39	42	34	33	29
Commercial-Institutional	60	40	30	40	30	30	20	20	17	20	23	23	20	18
Residential	20	10	10	10	10	10	10	10	9	9	10	13	12	13
Fuel Oil Total	270	240	230	210	180	160	120	120	99	123	120	127	125	117
Natural Gas														
Electric Utilities	6	5	6	6	6	5	5	5	5	4	5	4	5	5
Industrial	20	20	20	20	20	20	20	20	16	15	15	18	18	18
Commercial-Institutional	3	3	4	4	3	4	3	3	3	3	3	4	4	4
Residential	7	7	7	6	6	6	6	6	6	6	6	6	6	6
Natural Gas Total	36	35	37	36	35	35	34	34	30	29	28	32	33	33
Wood														
Industrial	180	120	130	130	120	110	100	100	96	96	96	94	94	94
Residential	460	490	870	990	1,020	1,110	1,110	1,120	993	1,002	1,010	997	1,026	985
Wood Total	640	610	1,000	1,120	1,140	1,220	1,210	1,220	1,090	1,098	1,106	1,091	1,121	1,079
Other Fuels														
Industrial	40	40	30	30	20	20	20	20	21	19	18	19	19	16
Residential	4	3	3	2	2	2	2	2	2	2	2	2	2	2
Other Fuels Total	44	43	33	32	22	22	22	22	23	20	20	21	21	17
Fuel Combustion Total	4,630	2,768	2,450	2,408	2,337	2,207	2,046	2,096	1,788	1,783	1,762	1,740	1,765	1,738

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE B-8. EMISSIONS OF SULFUR OXIDES FROM FUEL COMBUSTION SOURCES
(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Coal														
Electric Utilities	14,330	15,200	14,550	14,190	13,550	13,270	13,250	13,890	13,655	13,265	13,178	13,041	13,344	13,599
Industrial	2,840	1,700	1,610	1,380	1,560	1,500	1,540	1,640	1,670	1,680	1,542	1,572	1,584	1,787
Commercial-Institutional	100	130	140	100	120	150	160	180	148	150	141	148	114	122
Residential	240	70	40	40	50	50	60	60	50	50	63	64	51	56
Coal Total	17,510	17,100	16,340	15,710	15,280	14,970	15,010	15,770	15,524	15,145	14,925	14,826	15,093	15,563
Fuel Oil														
Electric Utilities	1,450	1,370	1,440	1,300	1,120	950	760	640	496	664	558	656	678	637
Industrial	1,140	880	910	850	680	700	420	480	487	523	557	449	436	379
Commercial-Institutional	800	580	480	580	440	430	280	280	267	308	337	345	303	275
Residential	190	180	160	140	130	120	100	120	121	134	132	175	169	182
Fuel Oil Total	3,580	3,010	2,990	2,870	2,370	2,200	1,560	1,520	1,372	1.629	1,584	1,625	1,585	1,474
Natural Gas														
Electric Utilities	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Industrial	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Commercial-Institutional	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Residential	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Natural Gas Total	5	5	5	5	5	5	5	5	4	4	4	4	4	4
Wood														
Industrial	4	4	6	5	5	5	6	6	6	6	6	6	6	6
Residential	6	6	10	12	12	13	13	13	11	11	11	11	11	11
Wood Total	10	10	16	17	17	18	19	19	17	17	17	16	17	16
Other Fuels														
Industrial	160	100	130	120	100	80	70	90	72	86	82	92	92	82
Residential	20	10	9	6	6	5	7	7	7	5	5	6	5	5
Other Fuels Total	180	110	139	126	106	85	77	97	79	91	87	98	97	87
Fuel Combustion Total	21,285	20,235	19,490	18,728	17,778	17,278	16,671	17,411	16,996	16,886	16,617	16,570	16,797	17,145

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE B-9. EMISSIONS OF NITROGEN OXIDES FROM FUEL COMBUSTION SOURCES

(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Coal														
Electric Utilities	3,170	3,880	4,820	5,150	5,250	5,200	5,410	5,710	5,932	5,823	6,066	6,332	6,429	6,416
Industrial	700	470	460	400	460	450	460	520	546	557	551	562	566	672
Commercial-Institutional	20	30	30	20	30	30	30	30	28	28	32	33	26	29
Residential	16	5	3	3	3	4	4	4	4	3	4	4	3	4
Coal Total	3,906	4,385	5,313	5,573	5,743	5,684	5,904	6,264	6,510	6,411	6,652	6,932	7,025	7,121
Fuel Oil														
Electric Utilities	390	590	560	440	370	260	250	220	170	245	209	263	278	273
Industrial	300	270	260	220	190	200	140	140	139	149	149	125	121	102
Commercial-Institutional	190	160	140	140	110	110	90	90	80	88	90	94	84	79
Residential	110	100	90	80	70	60	60	60	60	67	68	90	87	94
Fuel Oil Total	990	1,120	1,050	880	740	630	540	510	450	548	515	572	571	548
Natural Gas														
Electric Utilities	880	690	740	780	770	690	620	660	647	553	601	556	585	587
Industrial	2,770	2,570	2,710	2,240	2,140	2,230	1,950	2,110	1,969	1,902	2,193	2,265	2,284	2,370
Commercial-Institutional	110	110	130	120	110	120	110	110	110	105	104	121	123	121
Residential	220	220	220	220	210	210	200	210	201	196	198	210	217	200
Natural Gas Total	3,980	3,590	3,800	3,360	3,230	3,250	2,880	3,090	2,928	2,755	3,096	3,153	3,209	3,278
Wood														
Industrial	90	90	120	120	120	110	130	130	125	125	125	122	122	149
Residential	40	40	70	80	80	90	90	90	75	75	75	74	76	72
Wood Total	130	130	190	200	200	200	220	220	200	200	200	196	198	221
Other Fuels														
Industrial	50	50	70	70	60	60	50	70	32	35	34	36	37	29
Residential	60	40	30	30	30	20	30	30	34	30	31	32	35	35
Other Fuels Total	110	90	100	100	90	80	80	100	65	65	65	68	72	64
Fuel Combustion Total	9,116	9,315	10,453	10,113	10,003	9,844	9,624	10,184	10,153	9,979	10,528	10,920	11,074	11,232

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE B-10. EMISSIONS OF NON-METHANE VOLATILE ORGANIC COMPOUNDS FROM FUEL COMBUSTION SOURCES
(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Coal														
Electric Utilities	20	20	30	30	30	30	30	30	35	34	36	38	38	39
Industrial	4	3	3	2	3	3	3	3	3	3	3	3	3	4
Commercial-Institutional	1	1	1	1	1	1	1	2	1	1	1	2	1	1
Residential	55	20	10	10	10	10	10	10	12	12	14	14	11	12
Coal Total	80	44	44	43	44	44	44	45	51	50	54	56	54	56
Fuel Oil														
Electric Utilities	7	10	10	8	6	4	4	4	3	4	4	5	5	5
Industrial	4	5	4	3	3	3	2	2	2	2	2	2	2	2
Commercial-Institutional	4	3	2	3	2	2	2	2	1	2	2	2	2	1
Residential	4	4	4	3	3	2	2	2	2	2	3	3	3	3
Fuel Oil Total	19	22	20	17	14	11	10	10	9	11	10	12	12	12
Natural Gas														
Electric Utilities	5	4	4	4	4	4	3	4	4	3	3	3	3	3
Industrial	70	60	70	50	50	50	50	50	47	46	53	55	55	57
Commercial-Institutional	6	6	7	6	6	6	6	6	6	6	6	6	7	6
Residential	12	12	12	11	11	11	10	11	11	10	11	11	12	11
Natural Gas Total	93	82	93	71	71	71	69	71	67	65	72	75	76	77
Wood														
Industrial	50	50	70	70	70	70	70	70	74	74	74	72	72	72
Residential	350	370	640	730	744	800	790	790	698	700	700	688	709	674
Wood Total	400	420	710	800	814	870	860	860	771	774	774	760	781	746
Other Fuels														
Industrial	7	10	10	10	9	7	7	8	7	6	6	6	6	5
Residential	2	2	1	1	1	1	1	1	2	1	1	2	2	2
Other Fuels Total	9	12	11	11	10	8	8	9	9	7	7	8	8	6
Fuel Combustion Total	601	580	878	942	953	1,004	991	995	907	907	918	911	930	897

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE B-11. EMISSIONS OF CARBON MONOXIDE FROM FUEL COMBUSTION SOURCES

(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Coal														
Electric Utilities	100	120	160	170	180	180	190	200	208	205	215	227	230	231
Industrial	90	60	60	50	60	60	60	70	71	72	72	73	74	87
Commercial-Institutional	10	10	20	10	10	20	20	20	17	16	19	20	15	17
Residential	500	160	100	90	100	110	120	130	109	106	123	123	102	106
Coal Total	700	350	340	320	350	370	390	420	404	400	429	443	420	442
Fuel Oil														
Electric Utilities	40	60	60	40	40	30	20	20	17	24	21	27	29	29
Industrial	40	40	30	30	30	30	20	20	20	21	22	19	18	15
Commercial-Institutional	20	20	20	20	20	10	10	20	14	15	15	16	14	14
Residential	30	30	30	20	20	20	20	20	17	18	19	25	24	26
Fuel Oil Total	130	150	140	110	110	90	70	80	68	78	76	86	86	85
Natural Gas														
Electric Utilities	80	70	70	80	80	70	60	70	64	55	60	55	58	59
Industrial	420	390	410	350	330	340	300	320	302	293	332	345	351	359
Commercial-Institutional	20	20	20	20	20	20	20	20	22	21	21	24	25	24
Residential	40	40	40	40	40	40	40	40	40	39	40	42	43	40
Natural Gas Total	560	520	540	490	470	470	420	450	428	408	452	467	477	482
Wood														
Industrial	140	150	200	200	200	190	210	210	204	204	204	200	200	198
Residential	2,920	3,100	5,500	6,260	6,510	7,080	7,050	7,140	6,331	6,389	6,448	6,385	6,573	6,244
Wood Total	3,060	3,250	5,700	6,460	6,710	7,270	7,260	7,350	6,535	6,593	6,652	6,585	6,773	6,442
Other Fuels														
Industrial	10	20	20	20	20	20	20	20	12	11	11	10	11	8
Residential	10	10	8	6	6	5	6	7	8	7	7	7	8	7
Other Fuels Total	20	30	28	26	26	25	26	27	19	17	17	18	18	15
Fuel Combustion Total	4,470	4,300	6,748	7,406	7,666	8,225	8,166	8,327	7,454	7,496	7,627	7,598	7,774	7,467

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE B-12. EMISSIONS OF PM-10 FROM FUEL COMBUSTION SOURCES
(Gigagrams/Year)

Source Category	1985	1986	1987	1988	1989	1990
Coal						
Electric Utilities	0	0	0	0	0	0
Industrial	0	0	0	0	0	0
Commercial-Institutional	0	0	0	0	0	0
Residential	1	1	1	1	1	1
Coal Total	2	1	1	1	1	1
Fuel Oil						
Electric Utilities	19	28	23	29	30	30
Industrial	16	18	17	14	13	11
Commercial-Institutional	8	9	9	10	8	8
Residential	3	4	4	5	5	5
Fuel Oil Total	47	58	54	58	57	54
Natural Gas						
Electric Utilities	4	4	4	4	4	4
Industrial	16	15	15	18	18	18
Commercial-Institutional	2	2	2	2	2	2
Residential	6	6	6	6	6	6
Natural Gas Total	27	26	26	29	30	30
Wood						
Industrial	55	52	62	80	88	88
Residential	993	1,002	997	997	1,026	985
Wood Total	1,048	1,054	1,059	1,077	1,114	1,073
Other Fuels						
Industrial	7	8	8	9	10	10
Residential	2	1	1	1	1	1
Other Fuels Total	9	9	9	10	11	11
Fuel Combustion Total	1,132	1,149	1,149	1,176	1,214	1,168

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE B-13. EMISSIONS OF TOTAL PARTICULATE MATTER FROM INDUSTRIAL PROCESSES

(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Cattle Feed Lots (0211)	20	20	20	20	20	20	20	20	21	22	21	20	19	19
Cotton Ginning (0724)	20	20	20	20	30	20	10	20	24	17	26	27	21	25
Metallic Ore Mining (10)	530	320	210	180	200	110	110	130	129	114	130	128	153	149
Coal Mining (1211)	350	250	290	310	310	320	300	350	314	313	312	321	336	332
Crushed Stone (142)	1,350	760	570	450	380	340	370	400	421	482	477	578	574	603
Sand and Gravel(144)	50	40	50	40	40	30	30	40	41	46	46	45	46	49
Clays (145)	1,610	290	150	130	70	60	70	80	79	64	56	55	46	48
Potash/Phosphate Rock (1474,1475)	40	30	30	30	10	10	10	10	12	6	5	7	9	9
Feed and Grain Milling (204)	70	60	50	40	50	50	30	50	49	58	45	44	46	80
Lumber and Plywood (24)	80	70	80	70	70	60	70	80	82	92	98	98	96	104
Pulp Mills (261,262)	620	220	120	140	90	100	100	120	117	96	98	109	86	88
Chemicals (28)	220	120	140	140	120	100	110	130	118	90	95	97	101	103
Petroleum Refining (2911)	60	70	50	50	40	40	30	30	20	19	17	17	17	18
Asphalt Paving and Roofing (295)	560	320	130	110	90	90	110	140	118	124	133	127	125	133
Glass (321,322)	40	40	30	30	30	30	30	30	28	24	23	25	25	25
Cement (3241)	1,580	640	520	380	290	220	240	270	266	213	196	213	215	216
Brick and Tile (3251)	40	30	20	10	10	7	10	10	14	12	12	11	10	11
Concrete, Lime, Gypsum (327)	580	290	140	130	100	80	80	90	90	89	90	93	92	100
Clay Sintering (3295)	100	40	10	10	10	10	10	10	10	6	7	6	5	6
Iron and Steel (3312)	1,190	570	400	310	300	200	180	180	161	136	140	159	155	154
Ferroalloys (3313)	160	90	40	30	30	20	20	20	21	17	16	16	22	20
Iron and Steel Foundries (332)	150	70	60	50	40	40	30	30	37	35	38	40	46	47
Primary Nonferrous Smelters (333)	390	200	100	90	90	60	70	70	66	51	55	55	55	54
Secondary Nonferrous Smelters (334,336)	60	50	50	40	40	30	30	40	35	34	33	34	38	40
Grain Elevators (4421,5153)	670	590	550	490	550	510	280	430	489	390	346	353	353	364
Total	10,540	5,200	3,830	3,300	3,010	2,557	2,350	2,780	2,762	2,550	2,515	2,676	2,692	2,796

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.
Numbers in brackets are Standard Industrial Codes.

TABLE B-14. EMISSIONS OF SULFUR OXIDES FROM INDUSTRIAL PROCESSES

(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Natural Gas Production (1311)	100	160	140	140	150	130	170	150	148	154	175	172	175	178
Pulp Mills (261,262)	150	150	180	200	200	175	190	220	230	243	250	250	261	267
Sulfuric Acid (2819)	540	330	250	250	220	155	175	185	193	173	175	167	164	159
Carbon Black (2895)	0	10	10	10	10	10	10	10	13	13	14	15	15	15
Petroleum Refining(2911)	700	830	880	840	770	700	710	735	753	881	875	904	921	966
Glass (321,322)	20	30	30	30	30	30	30	30	26	26	24	27	27	26
Cement (3241)	560	460	630	570	550	460	505	550	565	545	541	567	573	575
Lime (3274)	30	30	30	30	30	20	20	30	24	24	24	26	26	26
Iron and Steel (3312)	650	620	580	510	480	310	290	340	326	294	323	365	364	372
Primary Copper (3331)	3,180	2,140	1,450	990	1,220	920	850	780	585	532	338	269	217	212
Primary Lead and Zinc (3332,3333)	410	110	120	70	70	145	110	110	220	189	185	213	171	205
Primary Aluminum (3334)	70	60	80	90	80	55	60	80	65	56	62	74	74	74
Secondary Lead (3341)	20	20	40	30	30	30	20	20	24	25	30	30	34	36
Total	6,430	4,950	4,420	3,760	3,840	3,140	3,140	3,240	3,172	3,156	3,014	3,078	3,023	3,111

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.
Numbers in brackets are Standard Industrial Codes.

TABLE B-15. EMISSIONS OF NITROGEN OXIDES FROM INDUSTRIAL PROCESSES
(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Pulp Mills (261,262)	20	20	20	20	20	20	20	20	23	25	26	26	27	28
Organic Chemicals (286)	60	60	70	50	50	40	50	50	53	55	60	60	62	64
Ammonia (2873)	30	40	50	50	50	40	30	40	42	34	40	41	41	42
Nitric Acid (2873)	150	110	100	100	90	60	50	50	43	33	29	26	26	18
Petroleum Refining (2911)	220	240	250	240	210	200	200	200	196	216	211	217	219	224
Glass (321,322)	40	50	60	50	60	50	50	50	49	50	46	51	51	49
Cement (3241)	90	80	100	90	80	70	80	90	92	89	88	92	93	94
Lime (3274)	20	20	20	20	20	20	20	20	17	17	17	18	19	19
Iron and Steel (3312)	70	70	70	60	60	40	40	50	46	42	45	51	49	50
Total	700	690	740	680	640	540	540	570	562	560	561	581	586	588

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.
Numbers in brackets are Standard Industrial Codes.

TABLE B-16. EMISSIONS OF NON-METHANE VOLATILE ORGANIC COMPOUNDS FROM INDUSTRIAL PROCESSES

(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Crude Oil Production, Storage and Transfer (1311,4463)	550	530	570	560	540	530	530	550	543	533	533	543	547	545
Food and Beverages (20)	190	170	180	170	180	180	180	160	171	156	161	167	155	156
Textiles (22)	10	20	20	20	20	20	10	20	19	12	13	15	15	14
Graphic Arts (27)	290	250	350	340	260	240	270	365	328	216	191	235	235	200
Plastics (2821,3079)	360	320	460	430	360	330	390	485	446	370	282	378	374	339
Organic Chemicals (286)	570	700	900	830	790	670	800	870	850	878	925	998	989	988
Other Chemicals (28)	620	500	630	570	590	510	550	555	507	512	552	566	552	552
Petroleum Refining(2911)	720	880	970	970	960	900	810	780	718	688	690	697	703	693
Rubber Tires (3011)	50	50	50	40	50	40	50	50	49	48	51	53	53	54
Iron and Steel (3312)	360	300	290	250	230	150	140	180	154	137	152	173	177	178
Petroleum Product Storage and Transfer (5171,5541)	1,580	1,760	1,700	1,540	1,490	1,430	1,400	1,420	1,420	1,463	1,521	1,529	1,531	1,574
Dry Cleaning (721)	240	230	290	290	240	210	220	260	219	165	170	212	212	197
Adhesives	50	40	60	50	40	40	40	60	53	37	26	39	39	33
Degreasing	640	450	560	510	420	360	410	510	492	338	394	372	372	348
Solvent Extraction Processes	40	30	40	40	40	30	40	40	44	38	44	38	38	40
Surface Coating	2,390	1,880	2,500	2,320	1,820	1,560	1,770	2,250	2,218	2,201	2,301	1,833	1,820	1,879
Other Organic Solvent Use	270	220	300	290	300	260	260	300	279	247	289	285	285	287
Total	8,930	8,330	9,870	9,220	8,330	7,460	7,870	8,855	8,510	8,037	8,294	8,132	8,098	8,078

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.
Numbers in brackets are Standard Industrial Codes

TABLE B-17. EMISSIONS OF CARBON MONOXIDE FROM INDUSTRIAL PROCESSES

(Gigagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Pulp Mills (261,262)	550	550	660	720	720	700	760	800	792	847	873	873	908	932
Inorganic Pigments (2816)	20	20	30	30	30	30	30	30	36	39	40	43	47	49
Charcoal (2861)	50	30	50	40	40	30	30	40	36	36	45	45	45	49
Organic Chemicals (286)	310	410	510	450	470	420	470	510	526	482	522	560	563	575
Ammonia (2873)	100	120	130	140	140	110	100	120	126	102	117	122	122	125
Carbon Black (2895)	2,600	1,420	1,590	1,290	1,320	970	1,030	1,190	1,060	1,056	996	1,057	1,054	937
Petroleum Refining (2911)	2,000	2,040	1,690	1,600	1,110	700	470	380	369	354	338	317	323	388
Asphalt Roofing (2952)	10	10	20	10	10	10	10	20	18	18	18	18	42	36
Lime (3274)	10	10	20	10	10	10	10	10	12	11	11	12	13	13
Iron and Steel (3312)	1,620	1,100	1,200	970	990	640	670	720	667	618	676	741	695	740
Iron Foundries (3321)	1,090	590	410	310	290	200	200	180	173	148	151	165	147	167
Primary Aluminum (3334)	590	580	750	760	740	540	550	670	574	500	549	658	661	654
Total	8,950	6,880	7,060	6,330	5,870	4,360	4,330	4,670	4,389	4,211	4,338	4,612	4,620	4,665

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.
Numbers in brackets are Standard Industrial Codes.

TABLE B-18. EMISSIONS OF LEAD FROM INDUSTRIAL PROCESSES
(Megagrams/Year)

Source Category	1970	1975	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Iron and Steel Industry	3,087	1,073	769	476	468	335	219	223	212	199	134	163	151	153
Primary Nonferrous Metals	12,350	5,569	1,316	1,038	859	874	871	679	828	635	643	656	692	628
Secondary Nonferrous Metals	5,612	1,905	1,391	1,020	883	784	694	784	796	774	827	893	1,025	1,036
Mineral Products	764	440	296	272	254	202	173	160	167	119	129	124	233	196
Miscellaneous	2,050	1,336	1,389	778	585	515	485	453	291	203	210	182	182	194
Total	23,863	10,325	5,161	3,584	3,049	2,710	2,442	2,299	2,294	1,930	1,943	2,018	2,281	2,208

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

TABLE B-19. EMISSIONS OF PM-10 FROM INDUSTRIAL PROCESSES
(Gigagrams/Year)

Source Category	1985	1986	1987	1988	1989	1990
Cattle Feed Lots (0211)	13	22	21	20	19	19
Cotton Ginning (0724)	9	0	0	0	0	0
Metallic Ore Mining (10)	112	114	130	128	153	149
Coal Mining (1211)	231	313	312	321	336	332
Crushed Stone (142)	455	482	477	578	574	603
Sand and Gravel(144)	11	46	46	45	46	49
Clays (145)	92	64	56	55	46	48
Potash/Phosphate Rock (1474,1475)	12	4	3	4	6	7
Feed and Grain Milling (204)	46	58	45	44	46	80
Lumber and Plywood (24)	95	92	98	98	96	104
Pulp Mills (261,262)	117	92	94	105	82	84
Chemicals (28)	133	90	95	97	101	103
Petroleum Refining (2911)	20	19	17	17	17	18
Asphalt Paving and Roofing (295)	97	124	133	127	125	133
Glass (321,322)	28	14	13	14	14	13
Cement (3241)	305	213	196	213	215	216
Brick and Tile (3251)	13	12	12	11	10	11
Concrete, Lime, Gypsum (327)	50	89	90	93	92	100
Clay Sintering (3295)	10	6	7	6	5	6
Iron and Steel (3312)	151	98	103	117	116	116
Ferroalloys (3313)	11	10	9	9	13	11
Iron and Steel Foundries (332)	37	35	38	40	46	47
Primary Nonferrous Smelters (333)	60	51	54	54	54	54
Secondary Nonferrous Smelters (334,336)	32	30	30	31	36	37
Grain Elevators (4421,5153)	520	390	346	353	353	364
Total	2,660	2,468	2,425	2,580	2,601	2,703

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding. Numbers in brackets are Standard Industrial Codes.

TABLE B-20. NATIONAL SUMMARY OF FUGITIVE DUST PM-10 EMISSIONS, 1985-1990
(Teragrams/Year)

Source Category	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Agricultural Tilling	6.2	6.3	6.4	6.4	6.3	6.3
Construction	11.5	10.7	11.0	10.6	10.2	9.1
Mining and Quarrying	0.3	0.3	0.3	0.3	0.3	0.3
Paved Roads	5.9	6.1	6.5	6.9	7.0	7.2
Unpaved Roads	13.3	13.3	12.7	14.2	13.9	14.1
Wind Erosion	3.2	8.5	1.3	15.9	10.7	3.8
Total	40.5	45.3	38.1	54.3	48.5	40.8

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

APPENDIX C - REGIONAL EMISSIONS

TABLE C-1. REGIONAL EMISSIONS ESTIMATES OF TOTAL PARTICULATE MATTER

(Teragrams/Year)

Region	1985	1986	1987	1988	1989	1990
I	0.2	0.2	0.2	0.2	0.2	0.2
II	0.3	0.2	0.3	0.3	0.3	0.3
III	0.7	0.7	0.7	0.7	0.7	0.7
IV	1.5	1.4	1.4	1.5	1.5	1.4
V	1.7	1.6	1.6	1.7	1.7	1.7
VI	0.8	0.7	0.7	0.7	0.7	0.7
VII	0.6	0.5	0.5	0.6	0.6	0.5
VIII	0.4	0.3	0.3	0.6	0.4	0.4
IX	0.8	0.7	0.8	0.7	0.7	0.7
X	0.5	0.4	0.5	0.5	0.4	0.9
Total	7.2	6.7	6.9	7.5	7.2	7.5

Note: 1990 emission estimates are preliminary.

TABLE C-2. REGIONAL EMISSIONS ESTIMATES OF SULFUR OXIDES

(Teragrams/Year)

Region	1985	1986	1987	1988	1989	1990
I	0.5	0.3	0.3	0.4	0.3	0.3
II	0.6	0.5	0.5	0.5	0.5	0.5
III	2.4	3.0	2.9	2.8	2.9	2.9
IV	4.2	4.2	4.1	3.9	4.0	4.1
V	4.9	4.9	4.8	4.7	4.8	4.9
VI	3.8	3.5	3.5	3.6	3.7	3.7
VII	1.5	1.4	1.4	1.5	1.5	1.5
VIII	1.7	1.4	1.4	1.6	1.6	1.7
IX	1.4	1.4	1.2	1.3	1.2	1.3
X	0.2	0.3	0.3	0.3	0.3	0.3
Total	21.1	20.9	20.5	20.6	20.8	21.2

Note: 1990 emission estimates are preliminary.

TABLE C-3. REGIONAL EMISSIONS ESTIMATES OF NITROGEN OXIDES

(Teragrams/Year)

Region	1985	1986	1987	1988	1989	1990
I	0.6	0.6	0.6	0.6	0.6	0.5
II	1.0	0.9	0.9	0.9	0.9	0.8
III	2.0	2.2	2.2	2.2	2.2	2.1
IV	3.7	3.6	3.6	3.6	3.6	3.5
V	3.8	3.6	3.6	3.7	3.7	3.6
VI	4.3	4.0	4.2	4.3	4.3	4.3
VII	1.4	1.2	1.2	1.4	1.3	1.3
VIII	1.3	1.1	1.2	1.3	1.3	1.3
IX	1.1	1.0	1.0	1.1	1.1	1.1
X	0.7	0.9	0.9	1.0	1.0	1.1
Total	19.9	19.1	19.4	20.0	19.8	19.6

Note: 1990 emission estimates are preliminary.

TABLE C-4. REGIONAL EMISSIONS ESTIMATES OF NON-METHANE VOLATILE ORGANIC COMPOUNDS

(Teragrams/Year)

Region	1985	1986	1987	1988	1989	1990
I	0.6	0.5	0.5	0.5	0.5	0.5
II	0.9	0.9	0.9	0.9	0.8	0.8
III	2.0	1.9	1.9	1.8	1.8	1.8
IV	2.7	2.6	2.6	2.6	2.5	2.5
V	3.6	3.4	3.4	3.4	3.2	3.2
VI	3.5	3.3	3.3	3.4	3.3	3.3
VII	0.8	0.8	0.8	0.9	0.8	0.7
VIII	2.6	2.3	2.4	2.5	2.2	2.2
IX	2.1	2.1	2.2	2.1	2.1	2.0
X	1.2	1.2	1.2	1.3	1.2	1.7
Total	20.1	19.0	19.3	19.4	18.5	18.7

Note: 1990 emission estimates are preliminary.

TABLE C-5. REGIONAL EMISSIONS ESTIMATES OF CARBON MONOXIDE

(Teragrams/Year)

Region	1985	1986	1987	1988	1989	1990
I	3.2	3.1	3.0	2.8	2.8	2.6
II	4.8	4.5	4.4	4.2	4.1	3.8
III	6.6	6.4	6.5	6.0	5.9	5.5
IV	14.1	13.1	12.9	12.8	12.8	11.4
V	12.9	12.3	12.2	12.0	11.6	11.1
VI	10.2	9.0	8.8	8.7	8.7	7.9
VII	3.9	3.5	3.4	4.0	3.7	2.9
VIII	3.9	3.1	3.0	5.3	3.1	3.0
IX	4.8	4.1	4.9	4.5	4.3	4.2
X	4.4	4.0	4.2	4.4	3.6	7.6
Total	68.7	63.2	63.4	64.7	60.4	60.1

Note: 1990 emission estimates are preliminary.

TABLE C-6. REGIONAL EMISSIONS ESTIMATES OF LEAD

(Gigagrams/Year)

Region	1985	1986	1987	1988	1989	1990
I	1.1	0.4	0.4	0.3	0.3	0.3
II	1.9	0.9	0.8	0.8	0.7	0.6
III	2.0	0.7	0.6	0.6	0.5	0.5
IV	3.8	1.3	1.2	1.2	1.1	1.1
V	4.5	2.1	2.0	1.9	1.9	1.8
VI	2.7	0.9	0.9	0.8	0.7	0.7
VII	1.9	1.1	1.1	1.0	1.1	1.0
VIII	0.8	0.3	0.3	0.3	0.3	0.3
IX	0.7	0.5	0.5	0.4	0.4	0.4
X	0.7	0.3	0.2	0.2	0.2	0.2
Total	20.1	8.4	8.0	7.6	7.2	7.1

Note: 1990 emission estimates are preliminary.

TABLE C-7. REGIONAL EMISSIONS ESTIMATES OF PM-10 FROM POINT AND FUGITIVE PROCESS SOURCES

(Teragrams/Year)

Region	1985	1986	1987	1988	1989	1990
I	0.2	0.2	0.2	0.2	0.2	0.2
II	0.2	0.2	0.2	0.2	0.2	0.2
III	0.5	0.5	0.6	0.6	0.6	0.6
IV	1.3	1.2	1.2	1.3	1.3	1.2
V	1.4	1.4	1.4	1.5	1.5	1.5
VI	0.6	0.5	0.5	0.6	0.6	0.6
VII	0.5	0.5	0.4	0.5	0.5	0.5
VIII	0.3	0.2	0.2	0.5	0.3	0.3
IX	0.6	0.6	0.6	0.6	0.6	0.6
X	0.4	0.4	0.4	0.4	0.3	0.7
Total	6.0	5.6	5.8	6.3	6.1	6.4

Note: 1990 emission estimates are preliminary.

TABLE C-8. REGIONAL EMISSIONS ESTIMATES OF FUGITIVE DUST PM-10

(Teragrams/Year)

Region	1985	1986	1987	1988	1989	1990
I	1.4	1.3	1.3	1.3	1.1	1.0
II	2.2	2.0	2.0	1.7	1.7	1.4
III	2.2	2.1	2.2	2.2	2.1	1.9
IV	5.7	5.6	5.9	6.2	6.2	6.1
V	7.1	6.8	6.8	6.7	6.3	6.0
VI	8.2	14.1	7.7	20.2	17.3	11.5
VII	4.5	4.6	3.9	6.6	5.7	5.2
VIII	3.2	2.8	2.9	3.8	3.0	2.9
IX	4.1	4.1	3.5	3.6	3.3	2.9
X	2.0	1.9	2.0	1.8	1.9	1.9
Total	40.5	45.3	38.1	54.3	48.5	40.8

Note: 1990 emission estimates are preliminary.

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